MACHINERY.

July, 1903.

## THE NEW FOUNDRY OF THE BROWN & SHARPE MFG. CO.—1.

The original building of the Brown & Sharpe Mfg. Co.'s plant at Providence, R. I., was erected in 1872 and was that part of the present main building where the office is now located. Eight years later, in 1880, a foundry was built directly west of the main building, which has since supplied castings for the works. This is a one-story structure, 266 feet long, with large window area and monitor roof and although 20 years old is much more modern in appearance than many buildings erected at the present time. Since this foundry building was completed the floor area of the machine shops has been increased several times by extensions to the main building and the addition of other buildings. These have increased the demand for castings to such an extent that it was impossible for the foundry to supply these demands and it became imperative that another foundry should be erected. This has recently been done, and the new foundry is now completed, or nearly so, and in running order.

In planning the new building, provision for future growth was made and it is intended eventually to have all the castings made in the new foundry. The set of buildings comprising the foundry are located on a plot of land on the northwest corner of the Brown & Sharpe Mfg. Co.'s ground, where there is ample room for future extension of the buildings. The plot is on the base of a hill or bluff sloping abruptly to the north and east, which necessitated considerable excavating. It is really a case of a foundry "under a hill," but instead of being a disadvantage, this conformation of the land has proven decidedly advantageous, since it has made possible the construction of storage bins for the foundry sand on a level with the foundry floor and on top of these a pig iron area with coke pockets on a level with the cupola charging floor.

In Fig. 6 of the group of views is shown the lower row of sand bins with the driveway and storage room on top. At the left is seen one end of a bridge leading to the charging floor. The upper building is for coke. Inasmuch as both structures are built against the side of the hill it was possible to arrange driveways leading on to the top of the sand bins and also on top of the coke pockets, so that both can be filled through manholes located in the roofs of the structures.

Fig. 1. Molding Floor of Heavy Foundry—This Foundry is thoroughly Lighted, Heated and Ventilated and the entire Floor Area is served by Traveling Cranes.

In Fig. 4 is a general plan of the foundry and in Fig. 2 an outline drawing representing the building as seen from the east, or from the top of the page containing the plan view. In the arrangement, taken as a whole, the feature to first attract attention is the division of the foundry proper in two parts for the light and heavy work, with the cupolas and charging floor between. In Fig. 4 the heavy foundry is located at the top of the drawing; next comes the cupola building containing, in addition to the cupola, the iron flask shop at the right and the core ovens and core room at the left. Next is the light foundry and finally the pickle beds and casting cleaning room, and the storage room. Above the storage room are lavatories and pattern storage rooms, while in the cupola building the wood flask shop is located, over the core room. All the other buildings are of one story only. In Fig. 3 as much of the plan as is drawn with solid lines has already been completed; but sufficient land is owned to enable

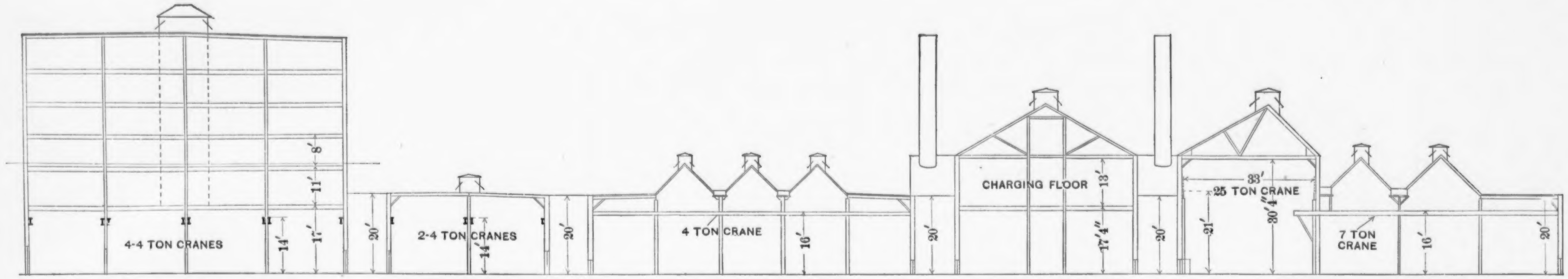



Fig. 2. Outline Sketch Showing Sectional End Elevation of Foundry Building.

the company to extend the various departments in a westerly direction, as indicated by the dotted lines, and foundations for the extensions are already in. It is expected eventually to erect a power building, as indicated, as a central power plant for the heating, lighting and power complete, for the whole foundry. At present boilers for heating are located in the delivery room.

From the general plan it will be seen that the different buildings are separated by light and air spaces about 10 feet wide, in the walls of which are side windows like the windows in the outside walls, thus making the central parts of the buildings much lighter than they would otherwise be.

The various departments are connected by a gangway extending from the storage building to the heavy foundry. Underneath the floor is a trench containing the piping for the water and steam distribution, etc., which is covered with iron plates that serve as a trackway for transferring castings, patterns and supplies on trucks with flat-tread wheels. The convenience of having the cupolas, flask shops and the core room so centrally located between the heavy and light foundry will be obvious. It will also be noticed that the cupola room is very centrally located with respect to the cast-iron area and coke bins. The core ovens are so designed that the heavier cores, which are used in the heavy foundry, may be withdrawn from the ovens on the foundry side after having been made in the core room and baked in the ovens, which avoids any additional handling.

In the construction of the buildings steel and glass have been used to as great an extent as possible. The walls are almost entirely of glass, and most of the windows have no brickwork between them. The sides of the window frames incase steel I-beams supporting the roof, or the floors above, as the case may be. In the buildings having floors above the first floor cinder concrete is used for the floors. The distance between the floor beams is 10 feet in the storage building and 5 feet in the cupola building, and the concrete is 5 inches thick, reinforced by twisted rods placed 1½ inches

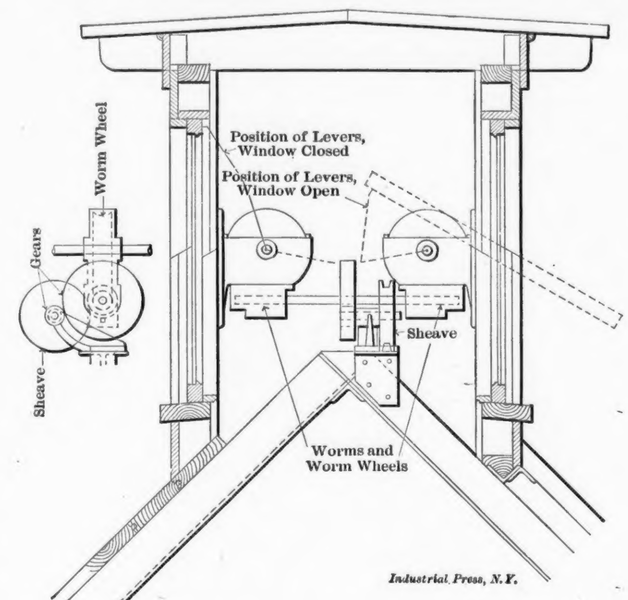


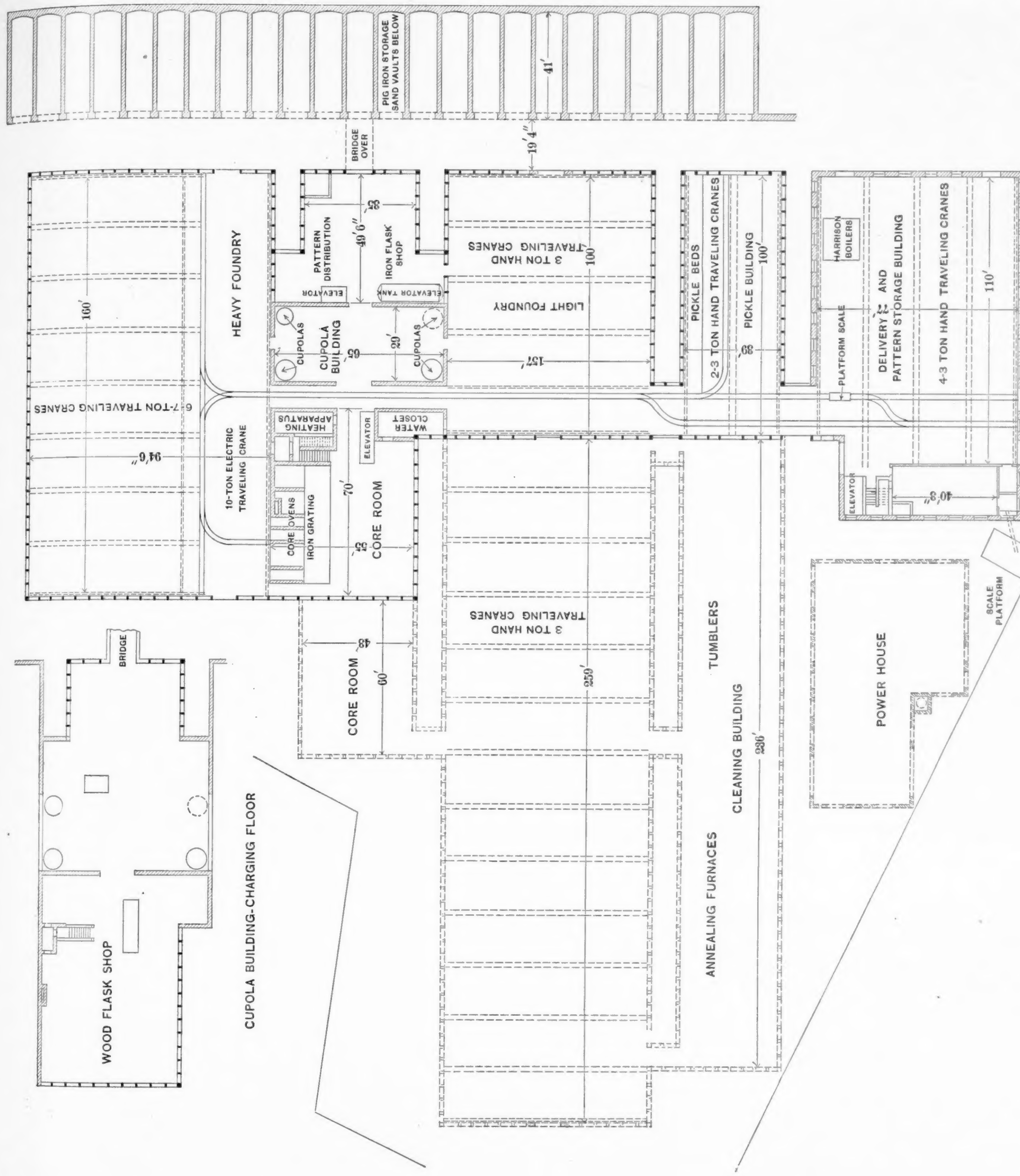

Fig. 3. Ventilation Arrangement of Monitor Roof.

from the lower side—the construction being what is known as the "Ransome" system of fireproof floor construction. The floor beams are standard I-beams, sufficiently heavy to carry the floor loads and incased in two inches of the concrete for fireproofing. The concrete is overlaid with spruce flooring 2 inches thick, nailed directly to the concrete and covered with a wearing surface of ⅞-inch maple.

In the two foundry rooms lighting is effected by the large windows in the walls and by windows in a modified form of saw-tooth roof, as shown in Fig. 2. Starting at the right in Fig. 2, it will be seen that the heavy foundry consists of two sections; one considerably higher than the other, which is served by a traveling crane, and the lower section, which is served by several hand cranes on tracks at right angles to the tracks for the main crane, the object of which is to make it possible to deliver ladles of iron from the cupola to the hand cranes as well as to handle castings, flasks, etc.

The roof of the high section resembles the regular saw-tooth roof, with one slope longer than the other and windows in the short slope facing the north. In saw-tooth roofs, however, the windows are usually at an angle of about 70 degrees with the horizontal, so as to exclude the direct rays of the sun when this luminary is high in the heavens in the summer time. In this roof the window slope makes an angle of 45 degrees, giving, of course, a much larger projected light area on the floor below, while provision is made for excluding the light up to the 70-degree angle by placing a monitor roof at the apex of the main roof, and extending its whole length. The monitor is high enough to practically shut out all direct rays from the floor and at the same time the benefit is gained of the superior lighting secured with the 45-degree roof.

The roofs covering the low section of the heavy foundry and also the light foundry are on the same plan as the roof over the high section of the heavy foundry; but in these cases each slope of the different roof sections is at an angle of 45 degrees, which gives a narrower span between the columns.




*Industrial Press, N.Y.*

**Fig. 4. General Plan of New Foundry of the Brown & Sharpe Mfg. Co.**

The south slopes of the roofs are covered with copper and the valleys with asphalt. The pitch of the roofs and width and slope of the valleys are sufficient to insure rapid disposition of the snow and water in the winter time—a feature generally lacking with the ordinary saw-tooth type of roof.

The monitors have windows for ventilation at the sides, and a section of one of them is shown in Fig. 3, in which is outlined the mechanism for opening and closing the windows. This is done from the floor by a chain passing over a sprocket wheel which is geared to a shaft carrying a worm at each end meshing with wormwheels on shafts running lengthwise of the roof. Levers at intervals on this shaft connect with the windows. This insures complete ventilation, so much to be desired in a foundry, whether in the winter or summer. The sash on the south side of the monitor are covered with galvanized iron to keep out the direct rays of the sun.

The efficiency of the lighting arrangements is manifest in Fig. 1, which is a view in the heavy foundry. This shows the building to be literally a glass house with a north light coming through the roof, and side light through the walls. Unlike most foundries this one has a cement concrete floor, adding to its cleanliness. A pit at the further end is used for molding the heaviest castings. This view also shows the crane arrangement, a Sellers electric crane being used for the high section and hand cranes with electric hoists for the low section. The foundry is equipped with stands containing shelves and lockers, one of which is seen at the left, for the reception of the molders' tools.

In the light foundry and other sections of the plant substantially the same crane arrangement is used as in the low section of the heavy foundry, viz., hand traveling cranes with electric hoists. By supplying each bay with one crane of this

Fig. 5. Delivery Room.

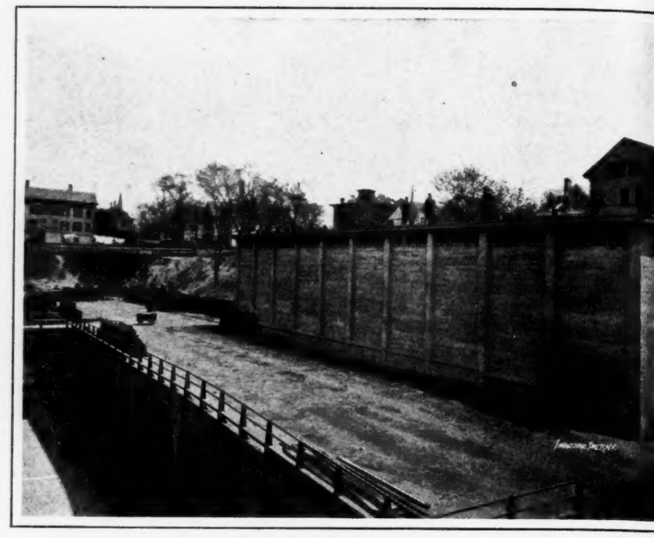


Fig. 6. Pig-iron Area with Sand Vaults below and Coke Pockets above.

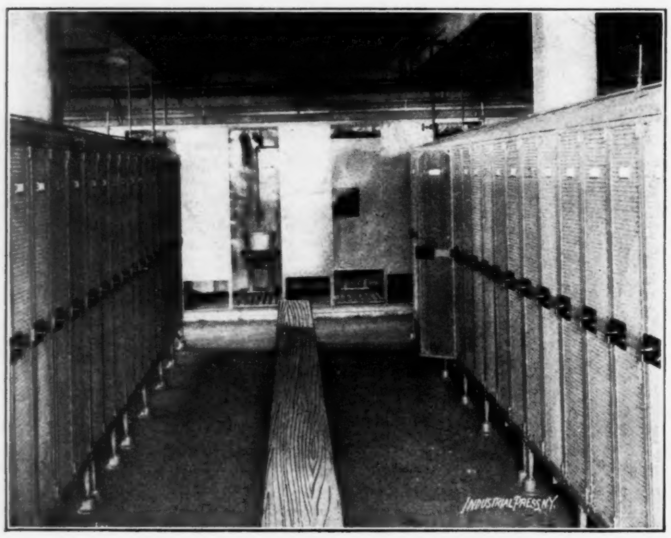



Fig. 7. View in Wash Room showing Lockers and Bath Rooms in rear.

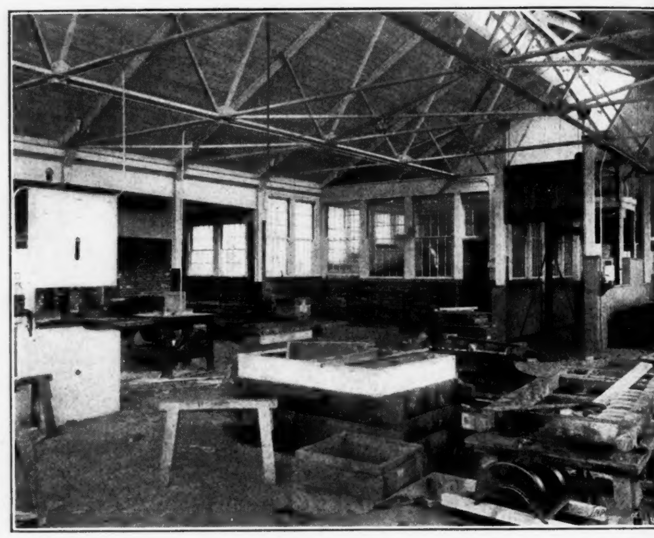


Fig. 8. Interior of Flask. Shop showing Motor-driven Machines and large Elevator.

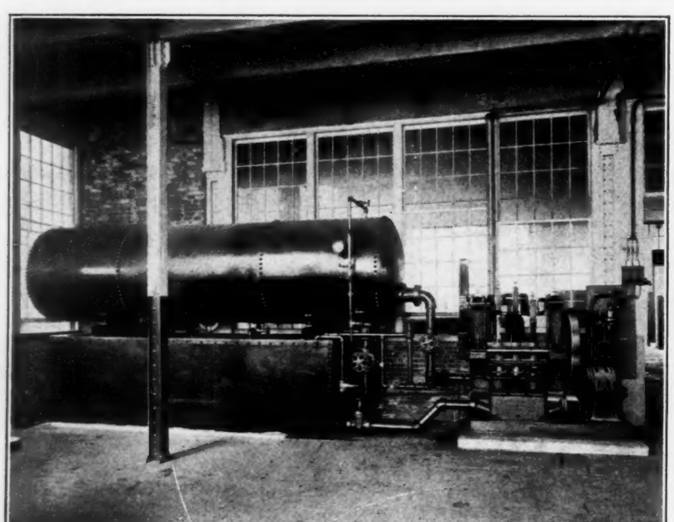


Fig. 9. Ten-H P. Induction Motor Geared to Triplex Pump, with Pressure Delivery Tanks for Operating Large Plunger Elevator.

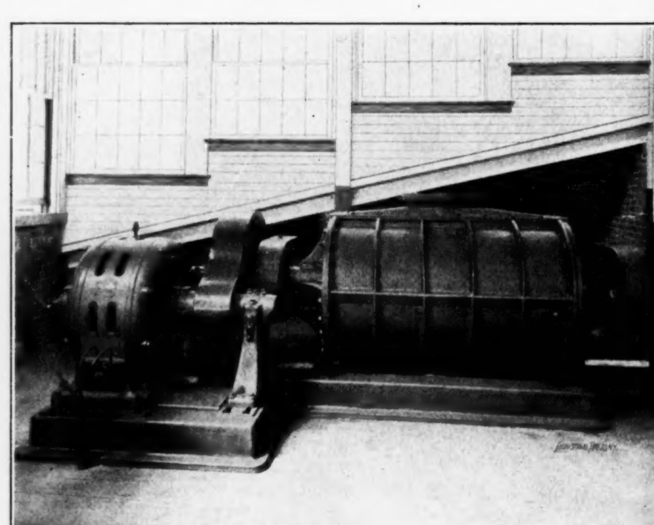


Fig. 10. Thirty-H. P. Induction Motor, Geared to No. 6 Roots Blower for Cupola Blast.

description work can be handled very efficiently without delays incident to waiting for a crane or helpers, and at the same time the whole floor area is served efficiently.

The hot blast system of heating is used, as far as practicable, and direct radiation for such rooms as cannot be reached by the indirect system. The conspicuous thing about the heating system is the absence of the usual sheet metal pipes leading to all parts of the works. For the heavy foundry the coils and fans are located in the cupola building and the hot air is discharged into the foundry through a single duct entering at one side, having five openings arranged in a semicircle so as to point to the different sections of the room, and diffuse the air through the room without creating drafts. For the light foundry, pickle room and office there is a second heating plant located so as to easily deliver air through the ducts leading to the different departments.

Cement concrete is used throughout for the arches of the sand vaults and the walls of the coke bin, the concrete being

mixed in proportion of 1 of cement, 3 of sand and 6 of broken stone. It is necessary to have the roofs of these two structures strong enough to sustain heavy loads, to withstand the wear of trucking and at the same time to be waterproof. The roof of the coke pocket is supported by I-beams and consists of 2¾-inch plank on furrings. Over these are three or four courses of felting paper, laid in roofing pitch and covered finally with chestnut planks spaced ¼ inch apart and the joint poured with pitch. The arches of the sand vaults are covered on top with wooden paving blocks. The iron fence built around the edge of the pig-iron area, on top of the sand vaults, is one of the numerous features about this foundry plant worthy of mention. The fence posts are of cast-iron and what corresponds to the lower rail of the fence is of heavy channel iron placed in a horizontal position and calculated to resist the attacks of unruly truck wheels. The upper rails of the fence are of wrought iron pipe. The electrical equipment of the buildings is complete and somewhat unusual for a foundry. The cranes are equipped with Westinghouse 500-volt direct-current series motors. For woodworking machines in the carpenter shop, the rattlers and

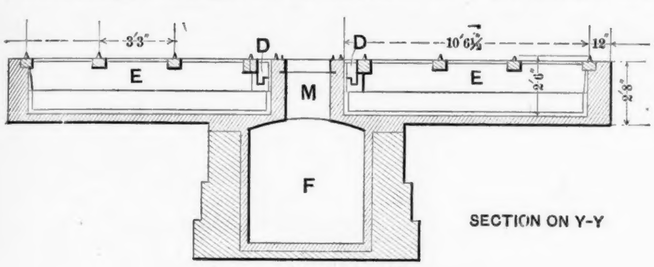



Fig. 12. Section through Pickle Bed.

the cupola blower, the General Electric Co.'s three-phase induction motors with 220-volt alternating current are used. These motors start easily under load. Their armatures are provided with a short circuit switch placed in such a position that at starting all the resistance is included in the armature circuit. As the motor increases in speed the resistance may be gradually cut out by the movement of a handle at the end of the armature shaft. By this arrangement a large starting effort is obtained and with this equipment the alternating current appears to give entire satisfaction.

In Fig. 10 is shown a Roots blower which supplies the blast

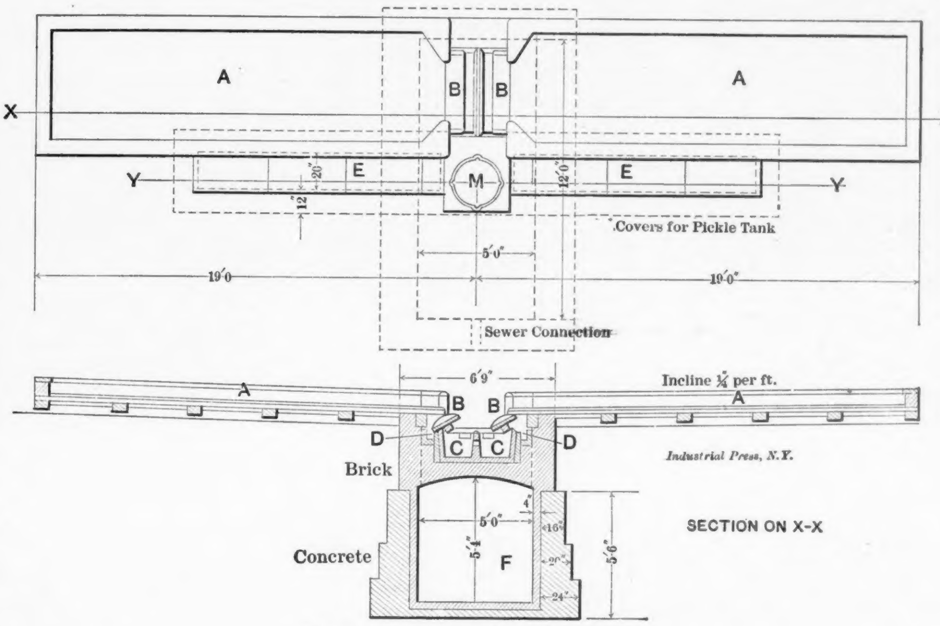



Fig. 11. Plan and Section of Pickle Bed.

for the single cupola that is at present erected—one of the Colleau pattern, made by Byram & Co., Detroit, Mich. This blower operates at 140 revolutions per minute and is geared directly to a 30 horse power induction motor. In order to secure quiet running outboard bearings were provided, both for the motor and the blower shafts. This gives a rigid support for the high-speed gearing and secondly, insures quiet running, with little liability to shut-downs.

A hydraulic elevator runs from the basement to the carpenter shop and the electrical equipment, pumps, tank, etc., for its operation are shown in Fig. 9. The elevator is made long enough to take boards of usual lengths in a horizontal position, instead of having to stand them on end. It is shown at the right in Fig. 8. The elevator pumping plant has a triplex Goulds pump, driven by a 10 horse power induction motor, which is started and stopped automatically on the variation of the tank pressure by means of a Mason regulator operating an oil switch of General Electric design. The upper or cylindrical tank, Fig. 9, is the pressure tank communicating with the elevator cylinder, and the lower or rectangular tank is for the discharge from the elevator cylinder and from which water is pumped to the pressure tank. The operation of the whole apparatus is entirely automatic, maintaining a constant pressure in the tank.


Fig. 13. Casting-cleaning and Pickle Room, showing Pickle Beds.

The pickle beds located in the pickling and casting cleaning building are of substantially the same design used by the Brown & Sharpe Mfg. Co. in their former foundry and are shown in detail in the illustrations, Figs. 11 and 13. Each bed is made in two sections, sloping toward the center, and is arranged to drain either into the acid tank or into the sewer, as desired. In Fig. 11, *AA* are two sections of the bed. The lower part of Fig. 11 is a sectional view taken on the line *X X*. *B B* are two tilting troughs that, when tipped one way, allow the liquid that has been poured over the castings to drain into the channels *D D* and, when tipped the other way, to drain into the channels *C C*. These latter channels drain into the settling chamber *F*, which is connected with the sewer. When the castings are washed off with a hose the water is allowed to drain into the chamber *F*, which allows the sand to settle and prevents it from going into the sewer. When using the acid, it drains into the channels *D D* and thence into the acid tanks *E E* shown in Fig. 12, which is a sectional view taken on the line *Y Y*, Fig. 11. The acid tanks are covered with wooden covers and by removing one of these the acid can easily be dipped up and poured over the castings. The manhole *M* gives access to the settling chamber, for cleaning. In Fig. 13 the swinging brackets by which the hose connection is had with the water pipe above the pickling beds, are clearly shown. Attention should also be called again to the excellent light, the walls of this room being almost entirely of glass.

The delivery and storage building, indicated in the diagram, Fig. 2, is at present only two stories high, but plans have been made for four additional stories to be erected later. Part of the second floor is used for lockers, wash rooms and bath rooms for the employees. The lockers are of expanded metal and steam pipes pass underneath the lockers not only to warm the room but to dry damp clothing in rainy weather. The work of the foundryman is so dirty that facilities for changing clothes and for bathing should be adjuncts of a modern plant, and these points have been carefully studied in this instance. In Fig. 7 is a view of the lockers, with two of the bath rooms shown in the background. It will be noticed that there is a bench between the two rows of lockers—a very simple affair but a great convenience to the employees when changing their clothing. The walls of the bath rooms are of sheet metal and in the corner of each bath room is a sheet metal locker in which clothing may be hung without danger of wetting it while bathing. A shower bath is not provided, but hot and cold water are supplied and there is a small bench or seat in each bath room on which a tub is placed holding two or three pails of water. The bench is made with a lid and after bathing the tub can be removed and the lid raised, providing a dry seat for the bather to use when dressing. This is a small detail but one of considerable importance to the man, if he wishes to emerge with dry clothes.

The floor of the main room and of all the bath rooms is of cement, but each bath room has a wooden grating making a comparatively dry floor on which to stand at all times.

* * *

A study of advertising schemes and devices, especially those to be seen in a great city, is interesting and instructive. Great sums are often spent in placing pictorial "ads" on the dead walls that will be exposed to public view only a few weeks at most before a new building on the adjacent lot will cover it. This seems like an extravagance, but it must be remembered that thousands see a display in such a position every day, whereas the same might be shown in a less thickly populated section for years before as many would be impressed by it, and that is, of course, what counts. Again novel locations are chosen that are effective because of the elevated position of so many of the dwellers in a great city. Ordinarily no one would think of painting a business sign on the top of a moving van to advertise the business of the owner, but in the city such a sign is fully as advantageously placed as those on the side of the vehicle.

* * *

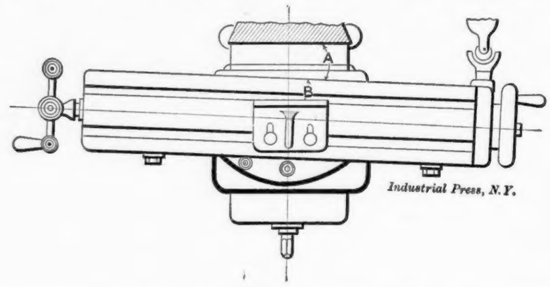
Another aluminum solder recently made public by the issue of patent privilege, is composed of aluminum, 5 parts; antimony, 5 parts; and zinc, 90 parts. The aluminum is first melted and then the zinc is added after which the antimony. The alloy is thoroughly puddled with sal-ammoniac until the surface is clear and white. It is then poured into bar moulds, making it ready for use.

## TOOLS AND METHODS FOR ACCURATE THREAD CUTTING.

JOS. M. STABEL.

Thread cutting, as a general thing, forms but a small part of a machinist's daily labor and as the average class of such work is accomplished in a very satisfactory manner, it may seem that little need be said regarding improvements upon present methods. If, however, one should stray away from the regular line of work and undertake making thread plugs, rings, taps, etc., he would find that there is a vast field open for improvement and he would no doubt appreciate a few suggestions from one who has had considerable experience in this class of work. Accurate thread cutting seems to be one of the trade secrets which is not easily mastered or often found described in books. When a man has established his method of accomplishing this work he generally holds on to it tight as he can, and he can hardly be blamed for so doing, since it requires a great deal of time and patience to secure satisfactory results. At the same time this man is wishing he knew the method employed in other shops and often fails to see the reason it is not made public.

FIG. 1. TABLE OF ANGLES USED WHEN MAKING THREAD CHASERS.



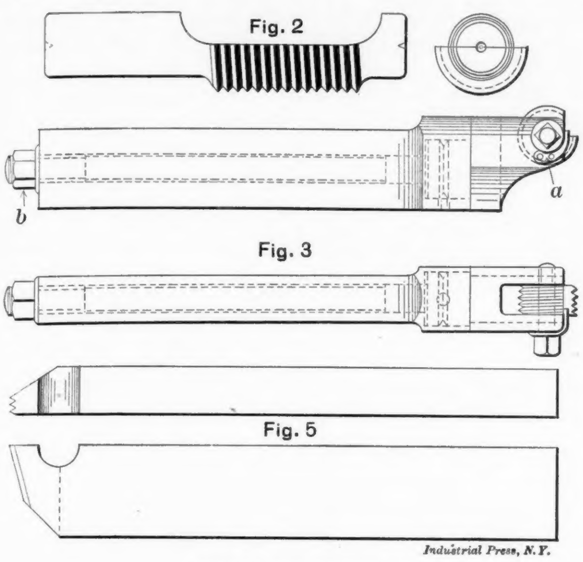

| Threads per inch | Angle B in Degrees and Minutes. | | | | | | | | | | | | | | | | Angle A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deg. | Min. | Deg. | Min. | Deg. | Min. | Deg. | Min. | Deg. | Min. | Deg | Min. | Deg. | Min | Deg. | Min. | Deg | Min. |
| 8 | .. | ... | .. | ... | 3 | 02 | 2 | 17 | 1 | 49 | 1 | 31 | 1 | 18 | 1 | 08 | 2 | 17 |
| 10 | .. | ... | 3 | 38 | 2 | 26 | 1 | 49 | 1 | 27 | 1 | 13 | 1 | 02 | .. | 55 | 1 | 49 |
| 12 | .. | ... | 3 | 02 | 2 | 01 | 1 | 31 | 1 | 13 | 1 | 00 | .. | 52 | .. | 46 | 1 | 31 |
| 14 | .. | ... | 2 | 36 | 1 | 44 | 1 | 18 | 1 | 01 | .. | 52 | .. | 44 | .. | 39 | 1 | 18 |
| 16 | .. | ... | 2 | 17 | 1 | 31 | 1 | 08 | .. | 55 | .. | 46 | .. | 39 | .. | 34 | 1 | 08 |
| 18 | .. | ... | 2 | 02 | 1 | 21 | 1 | 00 | .. | 49 | .. | 40 | .. | 35 | .. | 30 | 1 | 00 |
| 20 | 3 | 38 | 1 | 49 | 1 | 13 | .. | 55 | .. | 44 | .. | 37 | .. | 31 | .. | 27 | .. | 55 |
| 22 | 3 | 19 | 1 | 39 | 1 | 06 | .. | 50 | .. | 40 | .. | 33 | .. | 28 | .. | 25 | .. | 50 |
| 24 | 3 | 02 | 1 | 31 | 1 | 00 | .. | 46 | .. | 37 | .. | 30 | .. | 26 | .. | 23 | .. | 46 |
| 26 | 2 | 48 | 1 | 24 | .. | 56 | .. | 42 | .. | 34 | .. | 28 | .. | 24 | .. | 21 | .. | 42 |
| 28 | 2 | 36 | 1 | 18 | .. | 52 | .. | 39 | .. | 31 | .. | 26 | .. | 22 | .. | 19 | .. | 39 |
| 30 | 2 | 27 | 1 | 13 | .. | 49 | .. | 37 | .. | 29 | .. | 24 | .. | 21 | .. | 18 | .. | 37 |
| 32 | 2 | 17 | 1 | 08 | .. | 46 | .. | 34 | .. | 27 | .. | 23 | .. | 19 | .. | 17 | .. | 34 |
| 36 | 2 | 02 | 1 | 00 | .. | 40 | .. | 30 | .. | 24 | .. | 20 | .. | 17 | .. | 15 | .. | 30 |
| 40 | 1 | 49 | .. | 55 | .. | 37 | .. | 27 | .. | 22 | .. | 18 | .. | 16 | .. | 14 | .. | 27 |
| 48 | 1 | 31 | .. | 46 | .. | 30 | .. | 23 | .. | 18 | .. | 15 | .. | 13 | .. | 12 | .. | 23 |
| 56 | 1 | 18 | .. | 39 | .. | 26 | .. | 19 | .. | 16 | .. | 13 | .. | 11 | .. | 10 | .. | 19 |
| 64 | 1 | 08 | .. | 34 | .. | 23 | .. | 17 | .. | 14 | .. | 12 | .. | 10 | .. | 08 | .. | 17 |
| 80 | .. | 55 | .. | 27 | .. | 18 | .. | 14 | .. | 11 | .. | 09 | .. | 08 | .. | 07 | .. | 14 |
| 100 | .. | 44 | .. | 22 | .. | 15 | .. | 11 | .. | 09 | .. | 07 | .. | 06 | .. | 05 | .. | 11 |
| | 1/4" | | 1/2" | | 3/4" | | 1" | | 1 1/4" | | 1 1/2" | | 1 3/4" | | 2" | | | |
| | Diameter on which chaser is to be used. | | | | | | | | | | | | | | | | | |

NOTE.—All hobs to be 1 inch in diameter right-hand thread. Clearance on chasers, 15 degrees.

The writer has seen and done considerable of this work, and although the methods may not be wholly new they may be of interest to many of the readers of MACHINERY. While the method of making thread chasers was employed by Pratt & Whitney several years ago, the writer has never seen it described, and the tables shown in Fig. 1 and the style of hob and fixture for grinding same are original with him. That old saying "Patience is a virtue," is well recognized when doing this class of work. What can be more exasperating than to have a thread tool tear when on the finish cut, or, having made a nice plug and ring gage, to have the ring contract and the plug expand in length when they are hardened? There are any amount of such difficulties in the path of the thread gage and tap maker. That one little item, of the thread tool tearing the threads is greatly, if not wholly, overcome by adopting a chaser in place of a regular V thread tool, as the

chaser has three to five threads which tend to keep it from tearing into the work. The chaser is also far superior for cutting U. S. standard threads, as the flat top and bottom are sure to be perfect and can always be held to a standard with the aid of a master hob.

To make a chaser accurately is no small job, although quite simple when properly understood. The first thing is to make the hob, which is shown in Fig. 2. This requires great care as upon it depend all the threads of that certain pitch. The hobs are all made one inch in diameter, this size having been adopted so that the set of tables in Fig. 1 could be formulated. To accurately cut the hob the tool shown in Fig. 3 is utilized. This consists of a small circular thread chaser held in the body of the tool, the forward part of which is made separate from the shank so that it can be swiveled to suit the angle of the thread on the hob. A small piece of steel, *a*, serves as a gage for the cutting face of the circular chaser, so that it can be sharpened and re-set in the holder without disturbing the body of the tool. The nut *b*, on the end of the holder, serves to hold the forward part of the tool securely. After the hob is threaded it is milled out (as shown in Fig. 2) to its center line and then hardened. The object in milling it in this fashion is that it can be easily sharpened by grinding across the face, and this face is also utilized when setting the hob to its proper angle in the milling machine.




The Hob and Chasers.

The sharpening of the hob is accomplished with the special fixture shown in Fig. 4, which is simple in design and is made for use on a surface grinder where it is located so that its centers are at right angles with the emery wheel. The most essential point in grinding a hob of this description is to always grind the cutting face radially, in other words, the lower edge of the emery wheel must be in line with the center of the hob. To accomplish this is employed the little device in the shape of a lever, marked *a*, which has its fulcrum on the block *d* while its other end extends to the forward block upon which are graduated a few lines, about .05 inch apart, each division equaling a movement of .001 inch at the ball *b*. To set the emery wheel, the rear center *c* is removed from the block *d* and the emery wheel, at rest, is brought down onto the ball *b*. The table of the grinder is run to and fro by hand so that the wheel will pass over the ball thus forcing down the lever until it registers at zero, which denotes that the lower edge of the wheel is in alignment with the centers of the fixture. The center *c* is then put back in position and the hob, held by a dog, is placed between the centers and with the aid of the handle *e* is fed around, after each cut across the face, until it is sharpened. At no time during grinding is the perpendicular adjustment of the wheel altered. The ball *b* is a running fit in the lever *a* and on a small pin through its center.

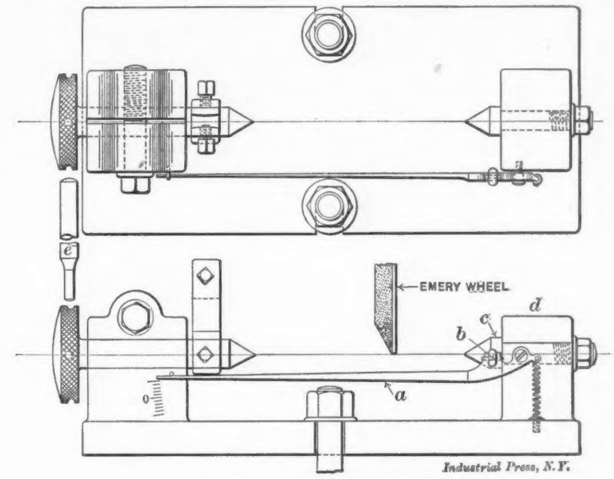



Fig. 4. Fixture for Grinding Hob.

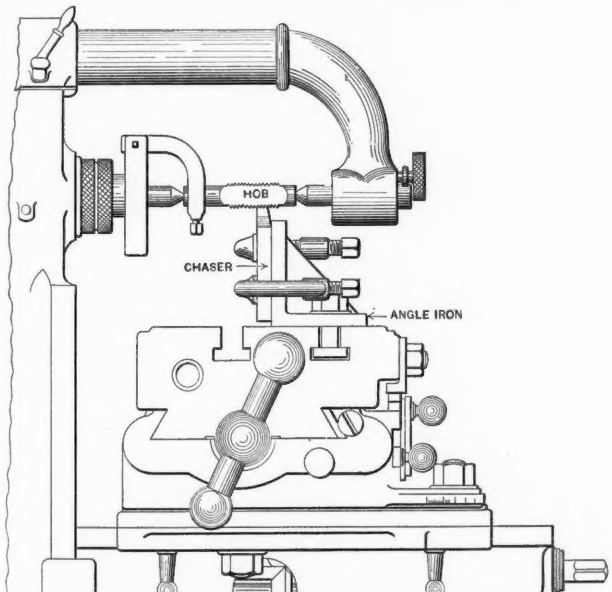



Fig. 6. Milling Machine arranged for Hobbing Chaser.

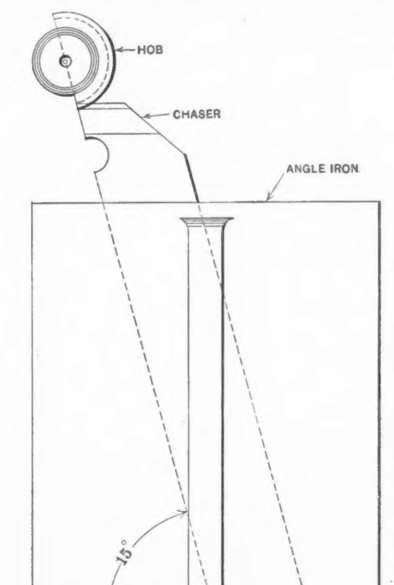



Fig. 7. Hob and Chaser in Position for Hobbing.

The hob being completed, the next step is to make, by use of the hob, the chaser shown in Fig. 5. This is made of tool steel, hand forged, and planed on all sides. It has a cutting clearance of 15 degrees and is placed against an angle iron which, in turn, is held on a milling machine table. The

hob is held between the centers of the machine spindle and the overhanging arm, as shown in Fig. 6, and when the cutting edge of the hob is accurately located the spindle is locked in position by means of a wooden wedge which is tapped in between the cone and the frame of the machine. The cutting face of the hob and the body of the chaser stand in a straight line and at an angle of 15 degrees with the table of the machine, as shown in Fig. 7. The most essential point in setting up the machine for this job is to get the angle iron located on the table of the machine at the proper angle for the threads to be shaped on the chaser; as a chaser made to use on a ½-inch tap will not work properly on a 2-inch tap of the same pitch because the angle of the thread is greater

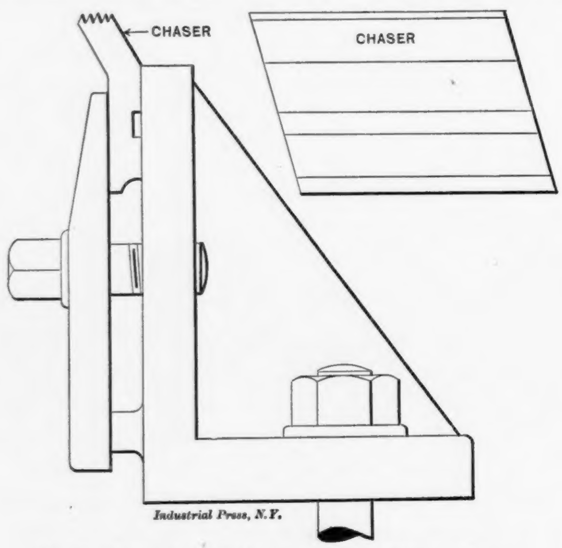



Fig. 8. Fixture for Hobbing the Pratt & Whitney Chaser.

on the former than on the latter. The milling machine table has also to be swiveled around to the proper angle of the thread on the hob, as the longitudinal movement of the table must correspond to the thread angle. For this purpose we make use of the table shown in Fig. 1. The plan view used at the head of this table will serve to illustrate the use of same. This is a plan of the milling machine table, showing it swiveled around, and also the angle iron set in the proper position. As will be seen, the table sets at an angle *A*, which is given in degrees and minutes in the right-hand column of the table, while the angle iron is placed on the table of the machine, making with the edge of the table the angle *B*. This is the proper angle for the threads on the chaser. Should it be desired to make a left hand thread chaser the angle iron would be placed at the same angle called for by the table but in the opposite direction.

As an example, we will suppose that it is desired to make a chaser that is to be used in making taps ½ inch in diameter having 26 threads per inch. We first look in the "threads per inch" column until we come to 26, then by following along the line we come to the last column, which gives us the angle

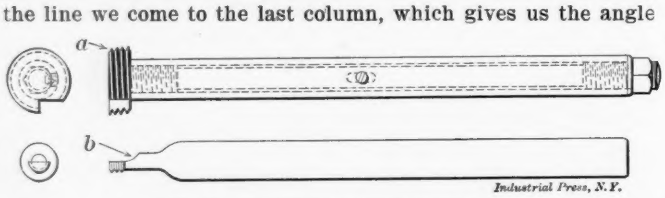



Fig. 9. Chasers for Internal Threads.

at which the milling machine table is to be set, or the angle *A*, which equals 0 degrees and 42 minutes. On the lower edge of the tables are the diameters on which the chasers are to be used and as in this case we have ½ inch, we follow up that column to the 26 pitch line, where we obtain the angle at which the angle iron is to be located on the table of the machine, or angle *B*, which in this case is 1 degree and 24 minutes. The machine being properly set, it is a small matter to shape the thread by moving the table to and fro and gradually feeding it upward until a perfect thread is obtained on the chaser. It is advisable to keep the hob well lubricated when cutting to insure a smooth thread on the chaser. A very good lubricant for this purpose is a mixture of one-half turpentine with one-half good lard oil. This will also be found an excellent lubricant for general thread cutting in the lathe.

Another style of chaser which has proved itself very useful may be worthy of notice. This is what is known as the Pratt & Whitney chaser, which is shown in Fig. 8. It is made separate from the body of the tool holder, in the angle iron shown in the same figure. For inside thread cutting the two tools shown in Fig. 9 can be used very handily. The one marked *a* is for large inside diameters and is composed of a tube through which runs a rod, threaded on each of its ends. Upon the front end is screwed a circular chaser which is held firmly against the tube by a nut on the other end of the rod. This makes a very handy device when chasers have to be changed, for by loosening the nut on the end, the chaser can be easily removed with the fingers. The solid chaser, *b*, shown in same figure, is for use on holes of small diameter the threaded part being milled half off. When sharpening this chaser care must be taken to always grind the face radially in order to insure accurate results.

* * *

## THE BURSTING OF EMERY WHEELS*.

Several years ago the writer was consulted regarding some points of a case in litigation occasioned by the bursting of an emery wheel and the resulting death of a workman. The question to be decided was whether the wheel was unsafe at the speed recommended by the makers, or whether the accident was due to the carelessness of the operator.

As it was just then an "off" year for experiments on flywheels there seemed to be no good reason why the same medicine could not be tried on emery wheels. The apparatus already described in former papers read before this Society,

TABLE.

| No. of Test. | Grade Mark. | No. of Emery. | Working Speed. Revs. per Minute. | Working Speed. Feet per Minute. | Bursting Speed. Revs per Minute. | Bursting Speed. Feet per Minute. | Speed Ratio. | Factor of Safety. |
|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | 20 | 1,200 | 5,030 | 3,100 | 13,000 | 2.58 | 6.67 |
| 2 | 4.5 | 20 | 1,200 | 5.030 | 3,200 | 13,400 | 2.67 | 7.14 |
| 3 | 4.5 | 20 | 1,200 | 5,030 | 3,350 | 14,020 | 2.79 | 7.73 |
| 4 | Q | 30 | 1,250 | 5,230 | 3,750 | 15,700 | 3 00 | 9.00 |
| 5 | Q | 30 | 1,250 | 5,230 | 2 750 | 11,500 | 2.20 | 4.84 |
| 6 | H | 30 | 1,400 | 5,870 | 4 550 | 19,050 | 3.25 | 10.56 |
| 7 | H | 30 | 1,400 | 5,870 | 4,600 | 19,200 | 3.28 | 10 76 |
| 8 | O | 36 | 1,250 | 5,230 | 4,100 | 17,200 | 3.28 | 10.76 |
| 9 | O | 36 | 1,250 | 5,230 | 4,125 | 17,250 | 3.30 | 10.89 |
| 10 | 2.5 | 60 | 1,150 | 4,830 | 2,750 | 11,500 | 2.39 | 5.71 |
| 11 | 2.5 | 60 | 1,150 | 4,830 | 2,900 | 12,100 | 2.52 | 6.35 |
| 12 | M. H. | 14 | 1,200 | 5,030 | 3.100 | 12,970 | 2.58 | 6.66 |
| 13 | | 24 | 1,200 | 5,030 | 3,800 | 15,900 | 3.17 | 10.00 |
| 14 | H | 10–12 | 1,200 | 5,030 | 4.100 | 17,200 | 3.42 | 11.70 |
| 15 | H | 10–12 | 1,200 | 5,030 | 4,350 | 18,200 | 3.62 | 13.10 |

Tests 6 and 7; wheels made with wire netting; tests 14 and 15, with vulcanized rubber.

with some slight alterations, was adapted to the new requirements, and in the spring of 1902, fifteen wheels of various makes were tested to destruction.

For the actual details of the work credit is due to Messrs. Chandler and Krueger of the class of 1902, Case School of Applied Science. Most manufacturers of this class of wheels test them for their own information, but the results are not generally given to the public; the writer knows of no published data on this subject. At the Norton Emery Wheel Works, all wheels are tested before leaving the shop at a speed double that allowed in regular service, and occasionally wheels are burst to determine the actual factor of safety.

* Paper read before Saratoga Convention of A. S. M. E., by Prof. C. H. Benjamin.

Emery-wheel accidents are not uncommon, but can usually be traced to the carelessness of the operator. One common cause of failure is allowing a small piece of work to slip or roll between the wheel and the rest. The writer was once present on an occasion of this kind, and although he fortunately was not in the plane of rotation, he has never forgotten his sensations.

The wheels selected for the experiments were all of the same size, being sixteen inches in diameter by one inch thick, and having a hole one and one-quarter inches in diameter.

The object of the experiment being to determine the bursting speed of such wheels as are actually on the market, emery wheels were obtained through various outside parties without indicating to the agents or manufacturers the use to be made of them.

In this way wheels of six different makes were obtained, the label on each wheel showing usually the maker's name, the grade number or letter, the quality of emery, and the speed recommended for use. As shown in the table of results, the working speed varied in the different wheels from 1,150 to 1,400 revolutions per minute, the average being about 1,200 revolutions per minute. For a diameter of sixteen inches this corresponds to a peripheral velocity of about 5,000 feet per minute. The table also shows that the fineness of the emery varied from ten to sixty, the average being about thirty.

The wheels were held between two collars, each six and one-eighth inches in diameter and concaved, so as to bear only on a ring three-fourths of an inch wide at the outer circumference.

The method of testing, and the apparatus used were precisely similar to those described in the paper on "The Bursting of Small Cast-iron Flywheels," by the author at a previous meeting, to which reference is made for illustrations of the apparatus.

The table shows the results of the experiments in detail, and needs but little explanation. The illustrations, Figs. 1 to 6 show characteristic fractures, and the appearance of various wheels after bursting.

Wheels numbered 1, 2, and 3, were of one make, and show a remarkable uniformity in strength. (Fig. 1.)

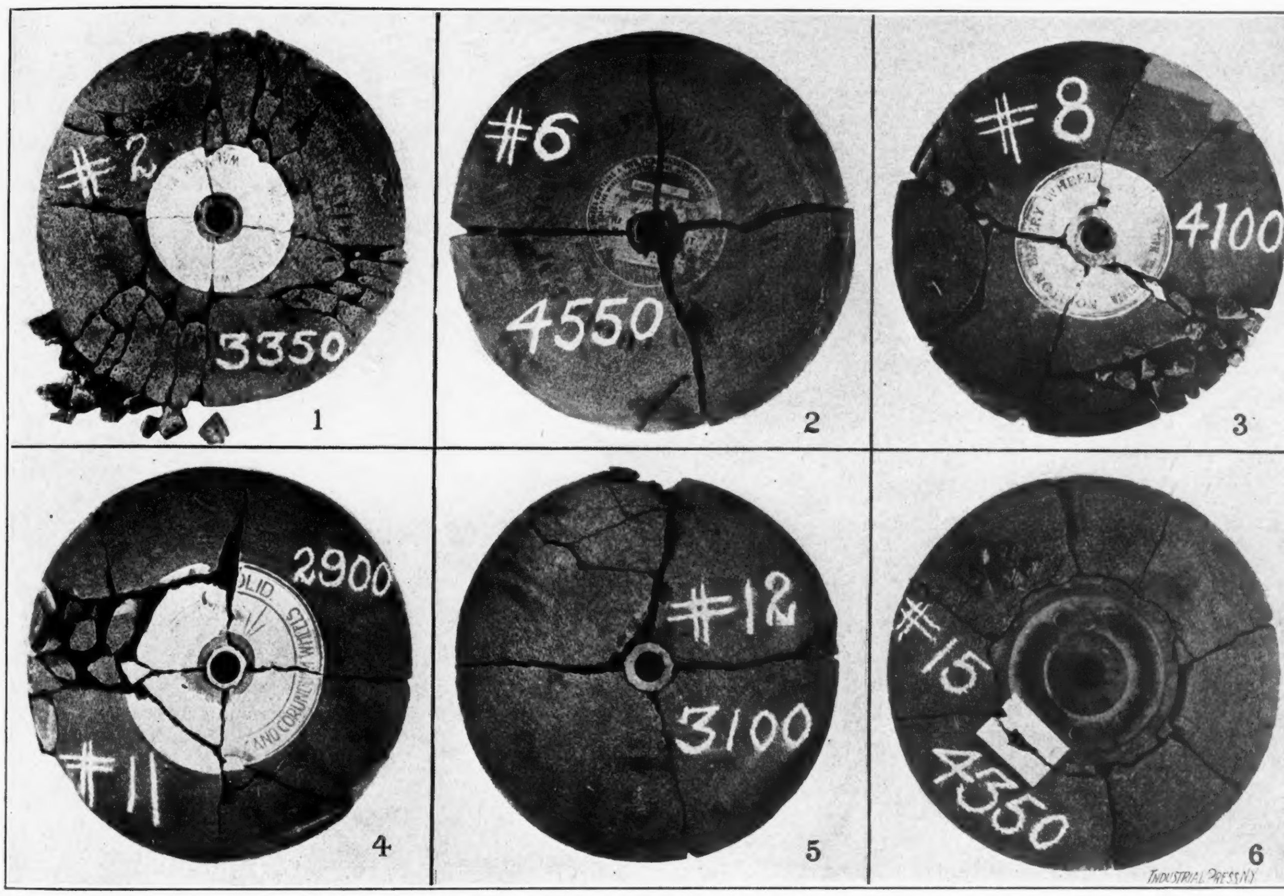
Nos. 4, 5, 8, and 9 were all made by one firm; the two latter wheels were of finer grain than the others, and show a correspondingly greater strength. (Fig. 3).

Nos. 6 and 7 contained a layer of brass wire netting imbedded in the emery, and were about one-third stronger than the average of the ordinary wheels. (Fig. 2.)

The wheels numbered 10 and 11 were the weakest among those tested, but have an apparent factor of safety of between five and six. (Fig. 4.)

Nos. 12 and 13, of still another make, burst at about the average speed. (Fig. 5.) Wheels Nos. 14 and 15 were so-called vulcanized wheels, containing rubber in the bond, and intended for particularly severe service. These showed, as was expected, rather more than the average strength. (Fig. 6.)

An examination of the last two columns in the table shows that the wheels burst at speeds varying from two and one-quarter to three and three-quarters the working speed, and accordingly had factors of safety, varying from five to thirteen.




Results of Experiments on Emery Wheels.

It is then apparent that any of these wheels were safe at the speed recommended, and would not have burst under ordinary conditions. At the same time, considering the violent nature of the service and the shocks to which they are exposed, it would seem that the factor of safety for emery wheels should be large. In comparison with those generally used in machines, a factor of eight or ten would seem small enough.

It may also be said that such a variation in strength between wheels of the same make and grade, as for instance, that between Nos. 4 and 5, indicates a lack of uniformity which causes distrust.

The fractures were in the main radial, as may be seen from the cuts, the wheel splitting in three, four or five sectors as might chance.

It may be assumed that these radial cracks started from the rim where the velocity and stress were greatest, but it is a fact worthy of notice that in nearly every instance the cracks radiated from points where the lead bushing projected into the body of the wheel.

## ENGINE AND BOILER TESTING.

W. H. BOOTH.

There are two or three different sorts of tests usually made on steam plants. First, there is the elaborate test with a score of observers and a high priest who sits in an arm chair and blows a whistle every ten or fifteen minutes as a signal to read instruments. I have observed that these tests usually give results out of all reason; too good to be believed. Then there is the test of the charlatan, whose results are of over 100 per cent. efficiency. Finally, there is the test made by ordinary engineers, who neither look for nor expect to obtain extraordinary efficiencies, and who have to hold the balance between buyer and seller without too hard-and-fast ruling on either side, but with fairness to both. Usually such tests cannot be made under the specified conditions, and allowances must be made both ways to allow for differences. In making such allowances, both sides must feel a confidence in the ability and good faith of the testing engineer, who must not be finical in his adherence to minutiæ, but must be able to form fair judgments in case of variation from specified conditions. It is open to question whether there be not at times too great elaboration in making tests, especially when it is a case of teaching students at a technical school where ideas of testing may be so biased as to be injurious to him in his future career.

It is advantageous for the students of a technical college to have the now usual experimental engine fitted with all manner of appliances upon and with which to make tests. But the elaborating of appliances does not always tend to make the student resourceful. I have observed in engineers brought up in shops of the highest class a lack of ability to devise means of getting over difficulties when dropped down in some backwoods kind of place away from appliances. Accustomed to the facilities of a big shop, there would be felt the absence of the overhead traveler, and the job of getting a boiler or heavy piece of machinery over a ploughed field or across to its place on a difficult foundation would be more easily carried out by the apprentice from the little shop. Similarly, high-class experimental engine testing cannot be carried into practice, and this is where the mischief of the experimental work comes in. In far too many cases the principal use of the experimental engine is the advertising of the professor. With an expensive tool purchased at public expense and an unlimited set of instruments, and a staff of students eager to take readings, very elaborate and full data can be obtained and these are published and serve to advertise the professor, who in this way gradually works himself up into a good practice as consulting engineer. Meanwhile, being conducted on an engine by no means of ordinary build or arrangement the figures and conclusions are apt to be of very small value. Further, they are apt to mislead students and it is probable that a cheap engine of less elaboration would tell more in the long run. It would be better that the subject of engine testing should be taught somewhat differently. The engine might be a plain one of commercial type and entirely free of appliances for testing. Then let the students begin from the beginning and devise the means of driving the indicator. Let them apply two indicators, or rather three—it will be good practice for them to test them for equality—one upon a pipe common to both ends of the cylinder and the other two on short connections. This will show them the effect of the pipe connections. On similar lines they should be taken all through, using such apparatus as can be roughed out. A great art in testing is to obtain good results from poor appliances, and when tests are to be made it is with poor appliances one has usually to work. Water supply for example is oftener drawn from a tank of large area and demands care in depth measurements. Weighing is better, but cannot be done. In order to keep as unbiased a mind as possible it is a good plan to leave out the tank area measurement until the depth of water used up has been ascertained. This tank measurement should, of course, be made with a rod and upward point. It is easier to see when a point breaks the surface of water when coming up from beneath such surface than when pointing down from above, as in the latter case capillarity interferes with accuracy.

In what may be termed ordinary testing the engine will be doing its regular work. It will not be grinding upon a brake and careful indicating will be necessary. There can be no comparison attempted between indicated and brake horse power. It will sometimes happen that engine testing will be found exceedingly painful and disagreeable. There is an inventor to be dealt with, and the testing engineer will have in his hands the making or marring of the man's fortune. It has been known that tests have been called for by promoters with the sole object of publishing the results, and all kinds of subterfuges have been resorted to in order to influence the results. In cases of this kind it is necessary to keep a very careful eye on the coal weighing, and even the coal pile, and such a test cannot be conducted without a sufficient number of assistants. But where a test is merely made for the satisfaction of the man who owns an engine and foots the coal bills and the intention of everyone is honest, an engineer by himself may, by working hard, obtain results of sufficient accuracy entirely unaided except by the ordinary staff. The fireman will himself weigh out the coal, and though he would probably make an error in counting the weighings he is not likely to make an error if with each barrow of coal he brings a tally in the shape of a marble or a chip of wood and deposits it in a basket in the boiler house. Such a test involves as its chief labor a large number of indicator diagrams, but I have known tests so carried out on a compound engine by means of one instrument only, the spring being changed every time the instrument was moved from cylinder to cylinder. No system of indicator test can be of any great value where loads are uneven, but they may be relied upon for such uniform and steady loads as occur in textile mills or flouring mills, where a full average load is carried all the time and any variation will be due to a gradual change of load, such as might arise from alteration in the efficiency of lubrication from a change of temperature. In a textile mill it is usual for the Monday morning load to be the maximum for the week. Machinery is cold, oil stiffened and lubrication deficient and these causes bring up the turning power for a time. The effect of different lubrication is very marked. Before mineral oils were so common the usual lubricant in an English cotton mill was sperm oil, which cost, if I remember rightly, about $2 per gallon. Sperm oil was undoubtedly good. It did not gum, and it flowed freely, and worked well with the light spinning spindles, but the growing scarcity of the cachelot whale rendered its oil liable to be adulterated and it was very costly. Mineral oil at half a dollar per gallon (10 lbs.) is now spoken of as expensive. A mill owner who had used nothing but sperm oil informed me that he had been making experiments with other oils, and on a total horse power of about 300 he had detected a difference of 20 horse power by an admixture with the sperm oil of half mineral at about half price. Mineral oil was then dearer than it is now. Any other mixture than half and half gave less good results. Thus by reducing the net cost of oil by one fourth he would save a considerable weight of coal, probably with his poor engine, 100 pounds per hour. Since high-speed engines for electrical working have become so common we have become accustomed to read very elaborate papers on steam economy and the professional element has been having a fine fling with elaborate tests. Now I have seen some of these high-speed engines run and I have been compelled to observe the exceedingly busy manner of the oil can and it has occurred to me that the time has arrived for some kind of tests to be made upon the oil consumption of modern steam engines. Oil costs about $100 per ton, one may say, or from 30 to 80 times as much as coal. In saving a ton of coal we must be careful it does not involve us in too many decimals of a ton of extra oil. With all the elaborate testing of the past few years and the loud talk about improvements and experiments, there is a continual tendency in practical construction to degenerate in respect of such details of construction as experience has shown to be necessary to durability and comfort. Now it costs no more properly to set a boiler to the plans which have been evolved by years of experience in the faults of older methods, and have been gathered together by quite an army of inspectors. Yet if a boiler be set without the supervision of experts it will assur-

edly be set on lines which are more or less retrograde and when this boiler comes to be worked it will not be so fully open to inspection as it ought to be. In England the standard boiler is the Lancashire type. As regards its brick setting this boiler is a cylinder 28 to 32 feet long, and 7 to 9 feet diameter. Its approved method of setting is such that though there are three longitudinal brick work external flues, involving four lines of contact of brickwork, every portion of the shell is visible to an inspector, and this result is secured simply by the use of properly formed firebrick seating blocks, which, while allowing of thorough inspection do not admit any serious leakage of gases between flue and flue. In old times the supporting walls of a boiler sometimes had a contact width of a couple of feet and any amount of corrosion due to possible leakage or damp foundations would take place out of sight until finally the boiler exploded unless it was so lucky as to spring a serious leak before being so much eaten away as to explode. Testing is all very well when carried out in a sensible manner, but it can only show shortcomings, and proper attention would often prevent the necessity of test. Our aim should be to construct upon the best lines. Attendants would then have no excuse for falling short in their upkeep. I have known a careful engineer with old engines and 60 pound boilers obtain his power for 2¼ pounds of coal per I. H. P. hour and he did this entirely by careful attention and upkeep, and out of the above fuel he warmed the mill and boiled some water for trade purposes. This man paid very particular attention to all vacuum joints and secured every possible ounce of vacuum that it was possible to get. He painted all pipes which inclosed a vacuum to close their pores, and he was careful with glands and packings, and with his firemen. Greater economy is possible with higher pressures and best conditions, but it is not so easy to maintain engines in order at high pressures, and without special care a modern engine may easily fall below the economy of a low pressure plant, thoroughly cared for. No man in charge of an old plant should allow this fact to excuse him of carefulness. "If only I had a new plant," he will complain, "I could do so much better." Now an old plant, if sound, is really more comfortable to attend and may be gotten up by care to a very high efficiency and kept there, too, with far less trouble and anxiety than can a modern high pressure plant, and it is likely to cost very much less in oil and incidentals.

* * *

### THE UNIVERSAL TECHNICAL DICTIONARY OF THE SOCIETY OF GERMAN ENGINEERS.

In the beginning of 1901 the Society of German Engineers (Verein Deutscher Ingenieure) began the compilation of a universal technical dictionary in the three languages English, German, and French. This undertaking has met with general approval and has received assistance from all quarters at home and abroad. Societies and individuals have responded generously to the invitation to collaborate and have proved their interest by the transmission of collections of technical words made by them or by promising such in the near future. There are now 341 societies (42 in English, 272 in German, and 27 in French speaking countries) co-operating in the work, and through these societies the Technolexicon has found helpers in Great Britain, Germany, France, the United States, and other countries.

Of the American societies may be mentioned the American Society of Civil Engineers, New York; the American Society of Mechanical Engineers, New York; American Railway Engineering and Maintenance-of-Way Association, Chicago; the American Chemical Society, Brooklyn; the Western Society of Engineers, Chicago, etc. Assistance has so far been promised by 2,185 industrial establishments and individual collaborators, many of which are in America.

For convenience's sake the Society of German Engineers has provided handy note-books (each with 3 indices A—Z) for the collaborators to write their collections therein. These books will be called in by the editor-in-chief in the course of 1904. So far 207 filled-out note-books have been forwarded voluntarily to the office at the address given herewith.

As the contributions will not be called in before 1904, all who wish to help in the compilation of the Technolexicon have still time and opportunity to assist in the preparation of their specialties. Contributions from all technical branches are welcome and it is obvious that small contributions from a host of various collaborators will be more useful than large ones compiled by a few men, who naturally cannot cover so many specialties. Attention is to be drawn to the fact that contributions in only one language are also most acceptable, though of course those in two or three languages are the most valuable. Delayed contributions, if they arrive before the end of 1906, when the printing will begin, can still be used.

The editor-in-chief will be pleased to give any information wanted. Address: Technolexicon, Dr. Hubert Jansen, Berlin (NW.7), Dorotheenstr. 49.

* * *

### SCHOOL TRAINING AND PRACTICAL EXPERIENCE.

A paper was read by P. M. Lincoln upon "The Training of the High Tension Engineer" before a recent convention of the Canadian Electrical Association, which contained some very good comparisons of the parts played by college and by practical experience in the making of a man versed in high-tension electrical work. He said:

The college instructs in those methods of doing things which have become standard by universal adoption. The college teaches positive knowledge. In the school of experience on the other hand, one is more apt to learn how not to do it, and by the elimination of the unsuccessful, arrive at the goal of success. The knowledge gained by experience is more often negative.

Put to the fresh college graduate the problem of the amount of distance to be left between the conductors of a high tension transmission line. His answer will involve most likely the jumping distance of the voltage to be used, the length of span, the sag and perhaps a liberal factor of safety. It is experience only that will show that his premises are wrong and that the equation to determine spacing of high tension wires depends very little on the voltages to be carried and almost entirely on such things as the average length and ohmic resistance of cats, the spread of wing of owls and cranes and eagles, and the average length of scrap baling wire, together with the strength of the average small boy's throwing arm.

The experiences of to-day are incorporated into the text books of to-morrow. But, although the result of experience may be taught to the college student—allowing always for a considerable angle of lag—the college curriculum can never become the substitute for the school of experience.

But it is furthest from my thoughts to cast any slur upon the technical graduate. I look back upon my own course in electrical engineering and feel that it is the most valuable asset I ever possessed. The technical course is the best of foundations, but it is only a foundation. The end of the college course is rightly called "Commencement." The great advantage of the technical education is that it gives the man proper equipment for overcoming the difficulties with which his experience is bound to bring him into contact. There is nothing like the college education to equip a man for making every accident a lesson in "how not to do it," and every failure a stepping stone to success.

* * *

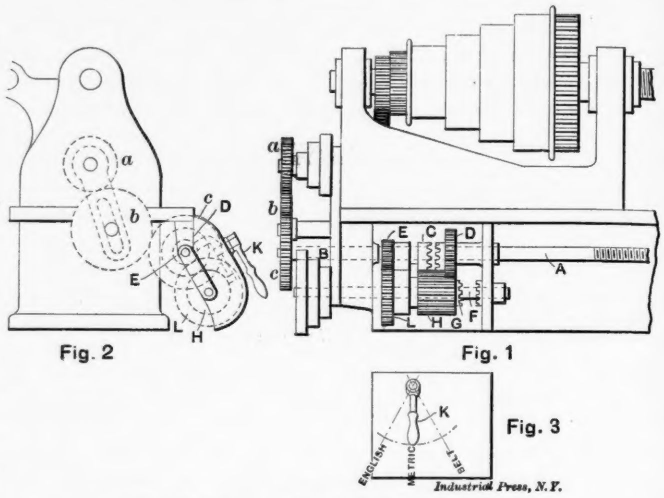
The growing use to which concrete construction is being put in engineering work is a matter of general knowledge, but the use of molten slag for making foundations is something that is known only in the vicinity of iron and steel plants. It would be difficult to find a more solid and enduring material for such purposes. James Christie in the discussion following the reading of a paper by Charles Piez, "Handling and Storing Iron Ore," stated that the foundations of the cantilever cranes of the Penn Iron & Coal Co., Canal Dover, Ohio, which are near blast furnaces, were made by digging trenches extending the whole length of the structure and filling them with molten slag. The concrete walls that support the traveling cantilevers, therefore, rest on immense monoliths of slag. A new steel mill was recently built by the United States Corporation near Pittsburg, Pa., on what was formerly a swamp, but which had been utilized as a slag dumping ground. The soft yielding surface was thereby transformed into an adamantine solid on which the heaviest machinery could be set with surety as to the permanence of foundations.

## THE EVOLUTION OF THE CHANGE GEAR.—2.

OSCAR E. PERRIGO.

The Patent No. 525,863, granted September 11, 1894, to Salmon W. Putnam, of Nashua, N. H., in so far as it related to cutting threads was for the purpose of cutting either the English or the metric standard threads without removing a change gear. It is represented in the drawings Fig. 1 showing a front, Fig. 2, an end elevation, and Fig. 3, the shifting lever by which the lathe is adjusted for English or metric threads or for a belt feed. The device consists of a lead screw in two parts, *A* and *B*, which may be connected by a clutch *C*, the toothed part of which is splined on that portion of the screw projecting through the head of the lathe and the other part formed upon the gear *D*, fixed on the portion of the lead screws threaded in the usual manner. Both the gears, *E* and *D*, engage a double gear *H*, splined on a short feed rod *F* (not extending to the apron). Fixed on the feed rod *F*, is one portion of a clutch *G*, formed upon the double gear *H*, having the gear *L*, formed upon it, the other portion being formed upon the bracket *J*, in which the rod *F* is journaled. The usual feed cone is also fixed upon the feed rod. These clutches were operated simultaneously by a lever *K*, which, standing in the position shown, enabled the lathe to cut metric threads. With the upper clutch *C* closed, English threads were cut. With the lower clutch *G* closed the usual belt feed was obtained, through the lead screw, upon which a sliding bevel pinion (not shown), operated the apron feed. The device is a compact arrangement for accomplishing the main object sought, that is, to readily change the lathe from English to metric threads and again to belt feed; but whether it would be of such frequent use in the average machine shop as to make its adoption general is somewhat doubtful. It should be said that the regular change gears were applied in the usual way, the device being adapted particularly for the different systems of threads. The lead screw also operated the feed rod.

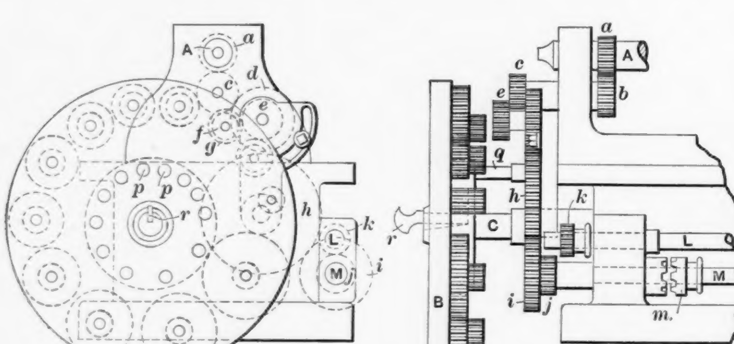
The first attempt at mounting all the change gears upon a circular plate which might be rotated to successively bring each of the gears into action, is described in Patent No. 536,615, granted to Edward Flather, of Bridgeport, Conn., April 2, 1895. This system requires considerable room at the head of the lathe and thirty-three gears of various sizes, with proper studs, swing plate, fastenings, etc., to cut only twelve different pitches of thread. An arrangement of clutches operator to revolve it to any desired position to bring the proper gears into engagement with the driving and transmitting gears, the series of pairs of gears carried by the plate being loose upon their studs and serving as compounding gears of varying ratios when brought into action. The revolving plate is provided with a series of holes *p*, located at proper intervals and engaging the fixed stud *q*, when the plate is forced back to its operative position after being brought to its proper place. It is prevented from working out of place by the spring catch *r*. The gear *k*, is splined



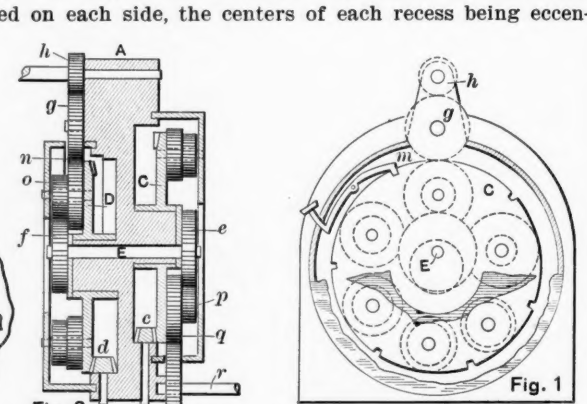

Salmon W. Putnam. No. 525,863, September 11, 1894.

to the lead screw *L*, and may be withdrawn from engagement with the gear *j*, when it is desired to drive the feed rod *M*, which is engaged by closing the clutch *m*.

Benjamin F. Burdick obtained on April 23, 1895, Patent No. 537,816, in which he introduces a double disk of gears, which are brought into action with the driving gear and the lead screw respectively by pivoting the gear disks or cases eccentrically upon a central shaft. The idea is ingenious and effective, probably as much so as is possible with the arrangement known as the "disk of gears." In the drawing, Fig. 1 is a face view or what would be, when it is applied to a lathe an end elevation. Fig. 2, is a vertical section, showing the eccentric location of the disks. The case *A*, is recessed on each side, the centers of each recess being eccen-




Edward Flather. No. 536,615, April 2, 1895.



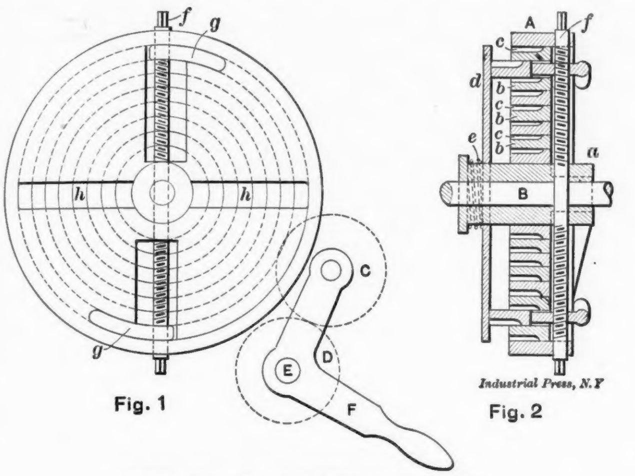

Benj. F. Burdick. No. 537,816, April, 1895.

makes this system of gears also available for driving the feed rod. The inventor mentions some modifications of this plan, which do not seem important and do not materially reduce its large number of gears and other parts. In the drawings, Fig. 1 is a front elevation and Fig. 2 is an end elevation of the invention. From the head spindle *A*, the power is carried through the gears *a*, and *b*, to the gear *c*, which will engage in turn with any one of the smaller of the pairs of gears journaled upon the revolving plate *B*, while the gear *e*, is likewise adapted to engage at the same time any one of the larger of the pairs of gears journaled on the plate *B*. This provides for the change from one pitch to the other, the motion being continued through the gears *h*, *i*, *j*, and *k*, the latter fixed to the lead screw *L*. The revolving plate *B*, is arranged to slide out upon its spindle *C*. This enables the

tric with the other. Upon the hubs formed in making these recesses are journaled two gear-carrying plates *C*, *D*, having bevel gear teeth formed upon them, which are engaged by the bevel pinions *c*, *d*, by which they are rotated to any desired positions. Through the center of this case is the transmitting shaft *E*, having fixed upon it the gears *e*, *f*. Each of the revolving disks carries, journaled upon fixed studs, a series of pairs of gears of unequal diameters, fixed together, and capable of being brought into engagement with the transmitting gears *g*, *h*, on the one side and the transmitting gear *k*, on the other, the eccentricity of the centers of rotation being exactly sufficient to do this. Each of the gear disks is held at any desired point by lever *m*, engaging suitable slots in the edge of the disk. Thus, for instance, the motion is conveyed from the lathe by the gears *h*, and *g*,

through the gears *n*, *o*, *f*, the shaft *E*, the gears *e*, *p*, *q*, and *k*, to the shaft *r*, and thence to the lead screw. By providing two disks of gears the number of changes is multiplied without the same addition of gears which would be required in the device of Edward Flather, last considered. If the disk of gears is to be used at all, the method of locating one or more of them, as desired, in an eccentric position relatively to the engaging gears, so as to conveniently bring either pair of gears into action without the use of catches, sliding movements and similar devices, would seem to be the best method.

It remained for Carl Johan Paulson, a Swede, of Brooklyn, N. Y., to invent an entirely new application of the principle of the cone of gears and traveling pinion, or at least an ingenious modification of it, which is shown in his Patent No. 541,385, dated June 18, 1895. In place of having a series of

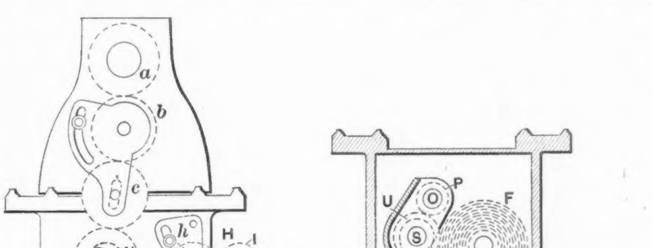



Carl J. Paulson. No. 541,385, June 18, 1895.

different sized gears side by side, he places them one within the other in the form of a series of rings, capable of being individually moved out to the position of action, where the teeth cut upon the ring are engaged by a pinion journaled on a swinging arm in the usual manner. In the drawings, Fig. 1 shows a face view of his device, and Fig. 2, a vertical section. In a circular case *A*, provided with a central hub *a*, is arranged a series of rings *b*, *b*, *b*, etc., completely filling the annular space. These rings have spur gear teeth cut upon them as shown at *c*, *c*, *c*, etc. They are prevented from becoming detached by the retaining plate *d*, which, in turn is held in place by the spring *e*. The screw *f*, has cut upon it right- and left-hand threads, upon which are fitted cams *g*, *g*, whose office it is to project the required ring as the cams are brought opposite to it by revolving the screw *f*. The central shaft *B*, is the driving shaft of the device and from either ring gear employed the power is transmitted by the gears *C*, and *D*, journaled on the swinging lever *F*, or vice versa, as may be desired. Each of the ring gears have lugs *h*, *h*, etc., formed upon them by which the whole device is revolved.

On November 2, 1897, Herbert L. Flather, of Nashua, N. H., was granted Patent No. 592,966, in which he makes use of the cone of gears fixed upon a supplementary shaft located in the lathe bed. The secondary shaft is parallel to it and has upon it the usual traveler carrying its pinion splined to the shaft, and the intermediate, or traveler pinion journaled in it. The lever by which the traveler is operated and fixed in position is an ingenious device and quite different from Norton's. The cone of gears arrangement is to be operated in connection with interchangeable gearing, much the same as the usual change gears, so that the older method of taking off and putting on gears was not wholly eliminated. In the drawing, Fig. 1, is an end elevation of the device; Fig. 2, is a transverse section of the bed, showing the cone of gears; and Fig. 3 is an inverted plan showing the cone of gears, shifting lever and their appendages. The power is transmitted from the head spindle through the gears *a*, *b*, *c*, to the gear *N*, on the transverse shaft *o*, upon which is journaled the shifting lever *R*, carrying the connecting gear *U*, journaled on the stud *S*. Upon the shaft *E* is fixed the cone of gears *F*, *F*, *F*, etc. (The shafts *E* and *O* are not connected by the gears *G* and *N*, as would appear in Fig. 3, one of these shafts being considerably lower than the other, as will be seen in Fig. 1.) The shifting lever *R*, is controlled in its movements by the guide plate *V*, and held at any desired point by the pin *x*, (actuated by the thumb lever *Y*,) entering the proper hole *w*, in the guide plate *V*. The power is carried on from the cone of gears, through the gears *G*, *H*, and *I*, to the lead screw *D*, and by the gear *T*, to the feed rod *Z*. The gears *G*, *H*, and *I*, are adapted to be changed in the usual manner whenever desired.

Patent No. 595,562, granted December 14, 1897, to Ernest J. Flather, of Nashua, N. H., is somewhat in the nature of a combination of Patents No. 470,591 and No. 519,924, granted to Wendel P. Norton, improved in the general arrangement and with some good points added. In this case the cone of gears, which by this time seems to have become very popular with inventors, is placed upon a short shaft in front of the bed and arranged to drive either the lead screw or the feed rod. In addition to this, the bevel reversing gears of Norton's patent, No. 519,924, are placed on the line of this shaft, to the left of the cone of gears, (and not shown in the drawing) which would seem to be a preferable position. The method of handling the traveling intermediate gear is ingenious and practical. In the drawing, Fig. 1, is a front elevation; Fig. 2, is a transverse section of the cone of gears and appendages; Fig. 3, is a section through the shifting lever and its connecting parts, and Fig. 4, is a perspective view of the same, showing its eccentric pivoting trunnions. The power for driving the lead screw is transmitted from the head spindle through the gears *a*, *b*, *c*, *d*, and *e*, in the usual manner, to the supplementary shaft *D*, upon which the shifting lever frame *K*, is journaled. Within this case is fitted the shifting lever *m*, carrying the connecting gear *h*, meshing into the shifting pinion *k*, on the shaft *D*. The shifting lever *m*, is pivoted upon an eccentric shaft *n*, by which it is brought into position as desired, and is readily

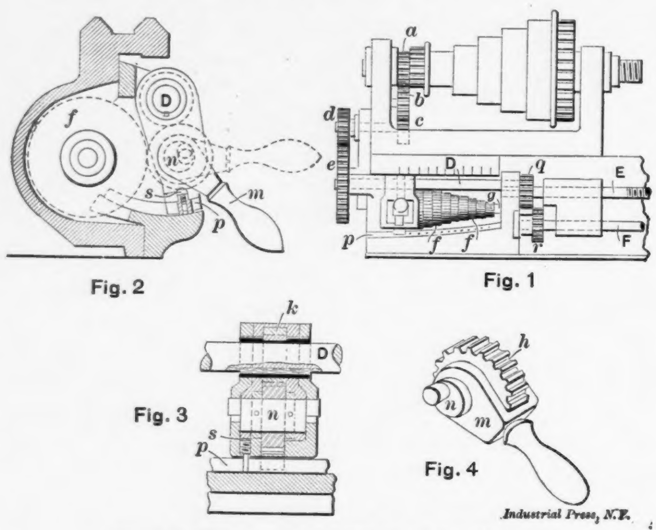



Herbert L. Flather. No. 592,966, November 2, 1897.

dropped out of engaging position when it is desired to shift to any other position. Its position in shifting is guided by the guide *p*, properly perforated for the spring pin *s*. Upon the right-hand end of the shaft *g*, is a gear, (not shown), meshing with the gear *q*, on the lead screw *E*, and driving it. Upon the feed rod *F*, is splined a gear *r*, which may be moved into engagement with the gear *q*, and thus power is transmitted to the feed rod.

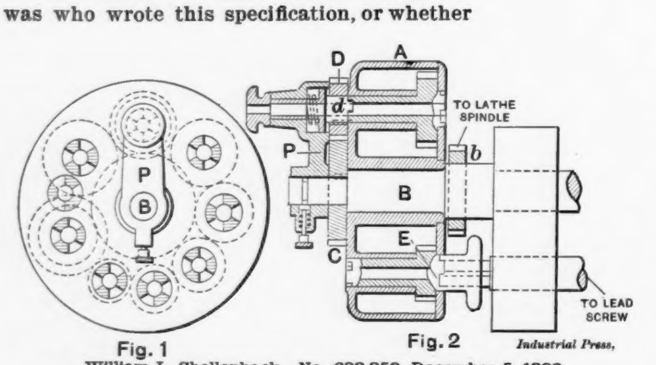
Benjamin A. Wheeler patented, April 26, 1898, (No. 602,924), a lathe in which he placed the cone of gears in the apron instead of in or near the head, connecting it with the lead screw by a clutch, which is closed by the lever operating the lead screw nut. Two cones of gears, on which the changes are made by a sliding key, are placed at the end of

the bed. The serious objection to the placing of the gears in the apron seems to be an undue loading down of the apron and carriage, as well as very much complicating these parts without a corresponding increase of efficiency. The inventor's reason for the innovation is the elimination of torsional strain in the lead screw, which is much more economically attained by enlarging the lead screw to a proper diameter. In the drawings, Fig. 1, is a side elevation; Fig. 2, is an end elevation; Fig. 3, is a longitudinal section through the cone of gears in the apron, and Fig. 4, shows a cross section




Ernest J. Flather. No. 595,562, December 14, 1897.

of the shifting lever. Power is transmitted in the usual manner from the head spindle, through the gears *a*, *b*, *c*, *d* and *e*, to the first cone of gears *f*, all of which engage the opposite gear of the cone of gears *g*, on the shaft *h*. Either of the gears of the cone *g*, may be brought into action by a sliding key operated by the knob *i*, thus making five changes of speed. Upon a sleeve mounted on the lead screw *E*, are the ten gears *j*, *j*, *j*, etc., forming the cone of gears. Upon the hub of the largest gear is formed a clutch member adapted to be engaged by a similar clutch member formed upon the sliding clutch *k*, upon which are also formed rack teeth *l*, engaging similar teeth on two bell-crank levers *m*, *m*, which are operated by pins fixed on the two parts of the lead screw nut *N*. The shifting lever *P*, carrying the connecting gear *Q*, is arranged and operates in the usual manner, as shown in Figs. 1 and 4. It is not known who the brilliant scholar was who wrote this specification, or whether

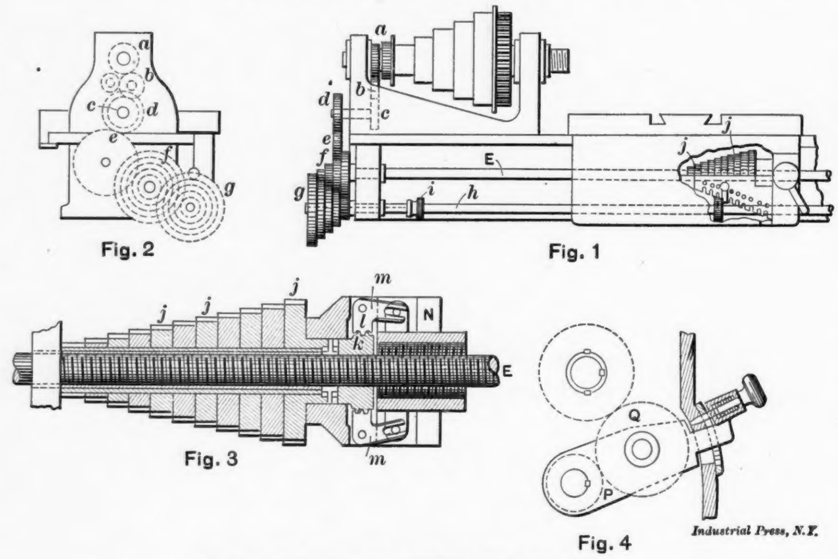



William L. Shellenback. No. 638,359, December 5, 1899.

he has been relegated to "innocuous desuetude" since the seven printed pages with their thirty claims were printed, but in several respects this document is a literary marvel, in five pages of which the personal pronoun, I, occurs about thirty times.

On December 5, 1899, William L. Shellenback, of Philadelphia, Penn., obtained Patent No. 638,359, in which he followed Edward Flather, 1895, and Burdick, 1895, in the arrangement of a disk of gears in which he simplified the device of Flather, but hardly equalled the ingenuity or efficiency of that of Burdick. In the drawings, Fig. 1 is a face view of the device, and Fig. 2 is a vertical section on the center line. A circular case *A*, contains the gearing, and is journaled on a main shaft, *B*, which is fixed to and derives its power from the head spindle through gear *b*. The main shaft has fixed to it driving gear *C*, engaging with the pinion *D*, fixed to a short spindle *d*, journaled in the rotating arm *P*. Arranged around the gear case *A*, is a series of gears, all engaging each other, as shown by the heavy dotted circles in Fig. 1, and provided with clutch members to be engaged as required, by the spindle *d*, of the rotating arm *P*, to transmit motion to the train, and by a similar clutch at *E*, to convey the power at varying speeds to the lead screw. By withdrawing the clutch *d* from engagement the rotating arm *P* may be carried around to a proper position to bring into action any gear of the series. While the changes are not great in number, they might easily be doubled or multiplied by four, by the usual arrangement of intermeshing cones of gears, or by sliding gears.

William L. Shellenback, in Patent No. 667,406, dated February 5, 1901, revised his device shown in Patent No. 638,359, making it a double disk of gears, and mounting them eccentrically after the manner shown by Burdick in 1895. In this device he improved quite considerably on his former effort in 1899, evidently profiting by the rapidly advancing state of the art, and the necessity for making a greater number of changes. In the drawing, Fig. 1 is a face view of the device; Fig. 2, is a vertical section, and Fig. 3, is an elevation of the reversing device. The device is supported upon an attaching plate *A*, which has formed upon it a sleeve, upon which the gear case *B*, is journaled. Through this case passes

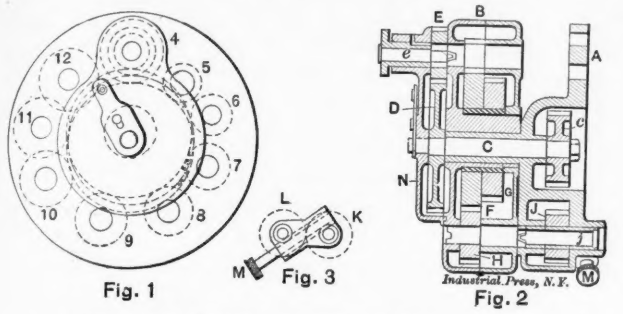



Benj. A. Wheeler. No. 602,924, April 26, 1898.

the main shaft *C*, having fixed upon it the gear *c*, which receives the driving power from the lathe. Upon the opposite end of the shaft *C*, is fixed the main driving gear *D*, engaging the gear *E*, in the rotating housing. Upon the hub of the gear case *B*, are journaled the gears *F*, and *G*, fixed to each other, the gear *F*, being adapted to mesh with the gears 4, 6, 7, 8, 9, and 11, of the front portion of the gear case, and the gear *G*, to mesh with the gears 5, 10, and 12, located in the rear portion of the gear casing, (not shown in Fig. 2). The gear casing *B*, being journaled eccentrically on the supporting sleeve, it follows that only the gears brought into engagement by arriving at the proper side of this eccentric movement will be in action. Each of the series of gears, 4, 5, 6, 7, 8, 9, 10, 11, and 12, are fixed upon shafts having clutch members formed upon both ends so as to engage with the clutch member on the end of the spindle *e*, of the secondary case *N*, on the one side, and with the clutch member on the spindle *j*, of the gear *J*, on the other. By thus providing for the revolution of the main gear case *B*, and the secondary gear case *N*, a large number of changes are possible. The device shown in Fig. 3, has two pinions cut on the shaft of the knurled head *M*, by which the spindles of the gears

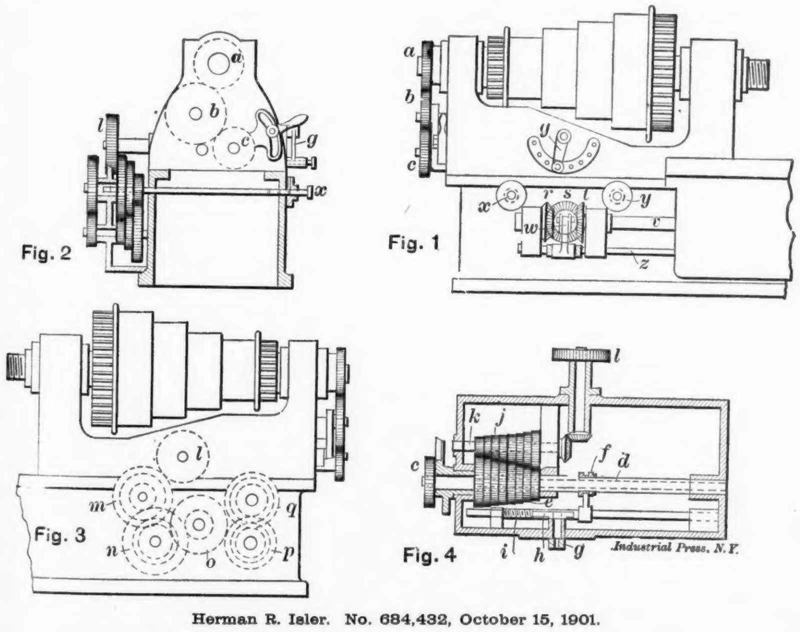
*L*, and *K*, may be moved, one into engagement and the other out, and *vice versa*, for the purpose of reversing the direction of the feed mechanism.

In Patent No. 679,568, granted July 30, 1901, to Edward A. Muller, of Springfield, Ohio, we find a combination of clutches, sliding splines, swinging stud plates, rack and pinion, gears mounted on disks, gears journaled in casings, gears on the head spindle, gears on primary shafts, gears on secondary




William L. Shellenback. No. 667,406, February 5, 1901.

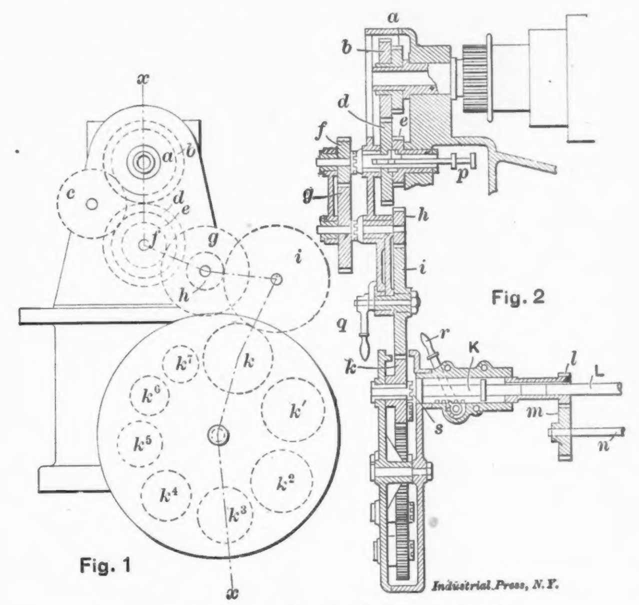
shafts, gears on supplementary shafts, in delightful profusion to the student, but we fear in confusion to the every-day mechanic. In the drawing, Fig. 1 is a face view of the invention, and Fig. 2, is a sectional development of the train of gearing on the dotted line *x*, *x*, Fig. 1. The direction of the transmission of power is readily seen in Fig. 1, from the gear *a*, through *c*, to *e*, or directly from *b*, to *d*, thence by the gear *f* to *g* and from *h* to *i* from which to any one of the series of eight gears marked *k*, $k^1$, $k^2$, etc., to the shaft *K*, and the lead screw *L*. From the lead screw the gears *l*, and *m*, drive the feed rod *n*. The gears *d*, and *e*, may either be brought into action by the rod *p*, operating the sliding key as shown in Fig. 2. The gears *f*, and *g*, are arranged with clutches as shown in Fig. 2, so that they and the connecting case in which they are journaled may be removed and another case of a different ratio of gears substituted, whereby the changes made possible by the gears *a*, *b*, *c*, *d*, and *e*, may be further increased. The gear *i*, is journaled upon a swinging arm clamped in position by the lever *q*, as may be necessary




Herman R. Isler. No. 684,432, October 15, 1901.

to bring the gear into engagement with any one of the series *k*, $k^1$, $k^2$, $k^3$, etc., as the gear case containing them is rotated. When the proper gear of the series is in position the shaft *K*, is brought into position to engage the clutch *s*, by means of the lever *r*. The shaft *K*, is splined to the sleeve on which the gear *l*, is formed. The lead screw *L*, is also splined to it and is thus driven with it.

Herman R. Isler, in his Patent No. 684,432, dated October 15, 1901, seems to have had great faith in the efficiency of the much used cone of gears, and may have thought that if they were good things, the more he had the better, for he not only places two cones of gears in the bed, but mounts four more cones of gears, together with various connecting gears at the back of the head on shafts journaled in the bed. These are all operated by sliding keys, while racks, segments, and bevel gears are introduced with a lavish hand. The arrangement doubtless proved rather expensive as well as unnecessarily complicated. It would not probably be too much to say that he was well acquainted with Norton's reversing bevel gears. In the drawing, Fig. 1 is a front elevation; Fig. 2 is an




Edward A. Muller. No. 679,568, July 30, 1901.

end elevation, showing the bed and a portion of the rear gear casings in section; Fig. 3, is a rear elevation, and Fig. 4, is a horizontal section through a portion of the head. The power is taken in the usual manner through the gears *a*, *b*, *c*, to the shaft *d*, upon which one cone of gears *e*, is journaled. Any one of these gears is brought into action by a sliding key operated by the clutch sleeve *f*, controlled by the lever *g*, through the medium of the segment *h*, and rack *i*. The gears of the cone *e*, engage those of the cone of gears *j*, fixed upon the shaft *k*, from which miter gears connect to the gear *l*, and thence to the series of gears at the back shown in Figs. 2 and 3. The motion here passes through the gears *m*, *n*, *o*, *p* and *q*, and thence to the reversing bevel gears *r*, *s*, *t*, to the lead screw *V*. The cone of gears *n*, and *p*, are fixed to their shafts, while those of the cone of gears *m*, and *q*, are controlled by sliding keys operated by the knobs *x*, and *y*. The reversing clutch *w* is operated by a quick-threaded worm on the reversing rod *z*, whose rotation is controlled at the apron.

* * *

What appears to be a simple scheme for greatly increasing the magnifying power of the microscope, has been developed by two professors in Jena University, according to a recent report from Consul Monaghan at Chemnitz, Germany. Some years ago the limit of microscopic perception was declared by the great physicist, Helmholz, to be 0.000004 inch, but it is estimated that the recent discovery will extend it to particles of matter so small as 0.0000002 to 0.0000003 inch. The principle depends upon strongly illuminating the particles to be observed, and excluding all rays of light from the objective save those that are reflected from the object observed.

* * *

A French experimenter has made a discovery that should be of value in blueprinting by electric light. He has found that an arc lamp using carbons having a core of carbide of iron, will make blueprints and black drawings on white ground, or heliographic paper, three times more quickly than when ordinary carbons are used.

Entered at the Post-Office in New York City as Second-class Mail Matter.

# MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to The Industrial Press, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1903.

NET CIRCULATION FOR JUNE, 1903,—27,165 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6x9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

One of the great drawbacks to the more general use of steel castings, as almost everyone knows, is getting them to come sound and reasonably true to pattern. It is somewhat discouraging to send a simple pattern to a steel foundry and receive in return castings that bear only a remote resemblance to the pattern sent, or are so full of blowholes as to be worthless. It is no exaggeration to say that this has been the experience of many manufacturers who would gladly be large users of steel castings if these could be obtained promptly and true to pattern. A more favorable aspect of the steel casting business was revealed to us on the occasion of a recent visit to the shops of the National Transit Co. at Oil City, Pa. This concern, which makes pumping machinery, gas engines, and other oil field machinery required by the Standard Oil Co., uses steel castings very largely for connecting-rods, crankshafts, and other machine parts requiring a strong, tough metal. These castings are made in their own foundry and they are without exception the finest specimens of the art we have seen. Mr. Klein, the former superintendent, now dead, invented a steel converter which is used and which is held to be largely responsible for the uniform results obtained. The foundry practice, however, reveals a grasp of the business on the part of the foundry foreman that shows he is master of his business. Almost everything is cast on end that can be handled in that way, gating from the bottom, of course, and providing risers of generous proportions. We were shown castings for a poppet valve of quite complicated shape, that is regularly made, which would test the skill of most molders to produce in cast iron. They were apparently perfect in every respect. In the production of three-throw crankshafts and other parts that are equally difficult to make, there seems to be no trouble in obtaining steel castings by this method that are true to the pattern and are satisfactory in every respect.

* * *

## CANNOT BE PREVENTED.

One of the most peculiar advertisements, (if we may so describe it) we have ever read, was inserted in the June issue of *Power* by an engineer of world-wide reputation—the father of the modern high-speed stationary steam engine. It is in effect a protest against the steam turbine, and is addressed to the builders of stationary and marine steam engines and would not call for special attention were it not that it so vividly illustrates a certain temper of the human mind that is periodically manifested whenever great improvements are first launched. The advertisement, in part, reads as follows:

Gentlemen: As you are well aware, your business is now confronted with the competition of the steam turbine. It is the prophecy of its promoters that the reciprocating steam engine will soon become a thing of the past. The general trend of engineering opinion seems to be in that direction.

Pumping and air compressing engines, and rolling mill engines, will not be affected by this competition. But the great classes of engines employed in most other industries, and for driving dynamos and marine engines are, *in their present forms*, pretty certain to be gradually superseded. On this point there seems to be little room for difference of opinion. The advantages of the turbine are very great.

Are there any means by which this threatened result can be prevented?

I am satisfied that this will be done by the more complete development of the high speed system—the combination of rapid piston velocity with short strokes. In this way a reciprocating engine will be obtained that will be preferred to the turbine. * * * *

As is sufficiently well known, I have devoted my life largely to the study and practical application of the principles of high speed engineering. For a number of years recently I have been engaged in maturing, both in its general features and its details, a high speed system which seems to me well adapted to present requirements. * * * * *

Steam engine builders, stationary and marine, are invited to communicate with me, when I will arrange to meet parties who shall propose to unite in this enterprise and lay its details before them.

Montclair, N. J. Charles T. Porter.

Superficially, this advertisement appears to be for the purpose of promoting a new invention, but we suspect that at heart the writer, who is a true engineer, with love for his profession, feels much deeper than this. The keynote of what he says seems to be: "Are there any means by which this threatened result can be prevented?" No matter if the steam turbine is better than the reciprocating engine, no matter if the world wants it because it is simpler, we, the men who have given our lives and best thoughts to the development of the steam engine, cannot bear to see it superseded. Vested interests are not of so much account here as sentiment. Naturally so, and this trait of human nature must be taken into account when dealing with men who have been prominently connected with the development of any great industry or enterprise. The father of the high-speed steam engine can perhaps console himself with the thought that if the steam turbine does supersede the reciprocating engine, it in turn will undoubtedly be shifted from the stage of action by some process for the direct conversion of heat into electrical energy. This is now accomplished in the laboratory and it is probable that it will eventually be done on a commercial scale.

It is perhaps impossible for any of us to view, without a tinge of sadness, the displacement of the old for the new, but improvements and progress are in effect synonymous with change. No motor, tool or appliance in the world of mechanics can crystallize into a permanent form; types must change or disappear as the conditions affecting them require. The lesson for the young man, and for all men to learn if they can, is that nothing is permanent and that if they would keep abreast with progress their minds must always be receptive to new ideas.

* * *

There is on record a considerable number of air compressor explosions, more or less disastrous, which are definitely known to have been caused by the "spontaneous" firing of confined explosive gases, of which the lubricating oil fed to the compressor cylinder, formed the hydrocarbon constituent. The heat generated by compression is sufficient to fire an explosive mixture of air and hydrocarbon gas, under favorable conditions, as can be demonstrated by experiment. The use of a lubricant for air compressor cylinders having innocuous qualities would seem desirable, especially where single-stage compressors are employed for pressures of 90 to 100 pounds or higher. Even if there is no danger of explosion there is always the trouble from carbon being deposited on the outlet valves and passages. The *American Manufacturer* of a recent date describes a lubricator for feeding soapsuds to an air compressor which is successfully used in the power plant of the Terminal Railroad Association at St. Louis, Mo. Soapsuds have been used there in an Ingersoll-Sergeant air compressor for the past four years. The lubrication has been satisfactory and the walls of the cylinder are said to be in perfect condition. All this being true, we have the very desirable elements of cheapness and superiority combined in a simple air cylinder lubricating compound available wherever people are addicted to the "soap-and-water habit."

## HIGH-SPEED PLANERS AGAIN.

In regard to high-speed planer work, which was discussed in the June issue, a belated report comes from the Mark Flather Planer Co., who say that on small planers 30-inch by 30-inch and under, a cutting speed of from 35 to 40 feet per minute is being employed with success, and that they are running planers of this size at about these speeds. They are operating a 42-inch by 42-inch planer, widened out to 50 inches, which has an 18-foot table and four heads, at a cutting speed of 28 feet per minute. But while this increase of cutting speed greatly increases the output, it is frequently necessary to make repairs. It does not appear possible to make certain parts of the planer, as now designed, strong and rigid enough to stand the shock and stress of such high speeds. Again the experience of this firm with the new high-speed steels, yields a varied degree of satisfaction. One tool may last for a long time with one grinding, and with such a tool the work progresses rapidly. Another tool, made possibly at the same time by the same smith and hardened in apparently the same way, will not stand up at all. The company are furnishing some 48-inch by 48-inch planers to the Locomotive & Machine Co., of Montreal, which are guaranteed to plane at 35 feet per minute. It is expected that these machines will show a great increase in consumption of power as the makers have found that the increase of power required is by no means pro rata with the increase of cutting speed, but rather in some geometric ratio. In conclusion they do not recommend high planer speeds, believing it is better to go a little more slowly and lengthen the life of the tools and the machine. A cutting speed of 30 feet per minute is recommended for planers 30 inches by 30 inches and under, and 25 to 27 feet for larger sizes up to and including 48-inch by 48-inch. Beyond these sizes the speed should be reduced from 22 to 23 feet per minute.

The highest high-speed record that has come to us, with the exception of a report from one G. A. Gray planer, which we understand is running at the rate of 66 feet cutting speed, has been sent by the American Tool Works Company, Cincinnati, who have paid a great deal of attention to the question of fast cutting speeds for planers. A test was recently made at their works upon one of their standard 24-inch machines, using in connection a well-known brand of high speed tool steel. The platen was planed off at a speed of 60 feet a minute, the depth of cut being ⅜ inch, and the feed 1-16 inch. The platen was then finished at the same speed without chatter, the cut being smooth, clean and even throughout. The same speed and cut was then repeated on a piece of work clamped to the planer table. Since these tests work has been done regularly on 30-inch planers at 60 feet a minute with this high-speed steel.

* * *

## THE NATIONAL MACHINE TOOL BUILDERS' MEETING.

The semi-annual meeting of the National Machine Tool Builders' Association held on June 9, 10 and 11 at Worcester, Mass., was more largely attended than any of the previous meetings. Interest in the objects for which the association was formed has steadily increased, and it may be now regarded as a permanent and successful adjunct of the trade. The only business of importance transacted was an agreement to increase the price of planers 5 per cent., but a number of minor points of general interest, such as the regulation of prices on machine tool parts were discussed, and steps taken to secure uniformity. Mr. W. A. Viall, of the Brown & Sharpe Mfg. Co., read a paper on the apprenticeship system in force at their establishment, which contained a number of valuable points. The visiting members of the Association and guests were entertained by the Worcester members at Lake Quinsigamond, and by the Norton Emery Wheel Co. at their works, and every one present had a most enjoyable time.

The following firms are members of the Association: Flather & Co., Mark Flather Planer Co., Nashua, N. H.; Jones & Lamson Machine Co., Springfield, Vt.; Baush Machine Tool Co., Springfield, Mass.; H. G. Barr, Blaisdell & Co., Draper Machine Tool Co., Prentice Bros. Co., F. E. Reed Co., Whitcomb Mfg. Co., Woodward & Powell Planer Co., Worcester, Mass.; Hendey Machine Co., Torrington, Conn.; Detrick & Harvey Machine Co., Baltimore, Md.; Binsse Mche. Co., Gould & Eberhardt, Newark, N. J.; W. P. Davis Machine Co., Rochester, N. Y.; B. F. Barnes Co., Rockford, Ill.; Hoefer Mfg. Co., Freeport, Ill.; Aurora Tool Works, Aurora, Ind.; Sibley & Ware, South Bend, Ind.; Bremer Machine & Tool Co., Kalamazoo, Mich.; American Tool Works Co., Bradford Machine Tool Co., Bickford Drill & Tool Co., Cincinnati Machine Tool Co., Cincinnati Milling Machine Co., Cincinnati Planer Co., Cincinnati Shaper Co., Dietz Machine Tool Co., Fosdick Machine Tool Co., Greaves, Klusman & Co., Hisey-Wolf Machine Co., Lodge & Shipley Machine Tool Co., R. K. LeBlond Machine Tool Co., Rahn, Mayer, Carpenter Co., Schumacher & Boye, Cincinnati, Ohio; Hamilton Machine Tool Co., Hamilton, Ohio; Fairbanks Machine Tool Co., Springfield Machine Tool Co., Springfield, Ohio.

* * *

## NOTES AND COMMENT.

The question of starting a course in "insurance engineering" at the Massachusetts Institute of Technology has been agitated for some time by the Factory Mutual Insurance companies of Boston and probably this result will eventually be consummated. The Armour Institute of Technology, Chicago, however, has gotten in ahead and has already started such a department for instruction in fire protection. The course is to be known as "Fire Protection Engineering," and will lead to the degree of Bachelor of Science. It will be under the direction of Prof. Fitzhugh Taylor, formerly engineer of the Underwriters' Laboratories. A special feature of the course will be a series of lectures by prominent insurance officials, architects and contractors.

---

"*The Aeronautical World,*" devoted to the interests of sky navigation, is one of the latest additions to the journalistic field. The advertising columns are the most interesting part of the paper. From them we learn that the Aeromobile (60 miles an hour guaranteed) for navigating the air, water or on land, is a new type of conveyance for which a limited number of orders will be booked at $600 each. The advertisement says, "Don't waste time asking questions, but if you mean business and command the cash send your order." Another inventor who has "proved" the practicability of a flying machine wants to raise the capital. Two people wish to sell gasoline motors which are "just the thing for air ships." Another man, who evidently tells the truth, advertises, "Clever performer with good hot air attachment is open to book engagements."

---

A contemporary gives a somewhat extended description of a variable-speed engine governor of the fly-ball type, in which the speed of the engine is changed by varying the relative position of two beveled friction disks which take the place of the familiar bevel gears. On general principles we believe a device of this nature should be discouraged. There have been entirely too many wrecks caused by runaway engines in which loose or broken belts have played the leading part. To introduce a friction device much more likely to slip and get out of order than the belt, is little less than criminal, and should never be allowed. An engine governor should always be positively driven either by chain or shaft connection. We are aware that blowing engines have been controlled by a variable-speed device of a similar nature to the one under discussion, but that does not alter the conditions affecting ordinary commercial engines. A blowing engine is always under close surveillance, and even then the device alluded to has often given serious trouble.

In one of his papers presented at the Saratoga convention, A. H. Eldredge tells of two engines which he equipped with positive governor drives, with marked improvement in their running qualities. The belt drives had not only given trouble through slipping and consequent irregular running of the engines, but at times had been in such bad shape as to become positively dangerous. The positive drives changed all this. Mr. Eldredge did what European engineers have practiced for many years and other American engineers may well follow their example.

# SIXTY-FOOT BORING MILL

## RECENTLY BUILT AND ERECTED AT THE GENERAL ELECTRIC CO.'S WORKS.

The boring mill, of which a description follows, was the subject of a paper by Mr. John Riddell, Schenectady, N. Y., before the Saratoga convention of the American Society of Mechanical Engineers. This machine was designed for machining field rings of dynamo-electric machines, flywheels and other large work at the General Electric Co.'s works, Schenectady, and is of such immense proportions and weight of material that it was necessary to build it at the factory where it was to be used. The total weight of the boring mill complete is 885,600 pounds and it is capable of taking work 60 feet in diameter. Up to the present time the largest boring mills in the country, so far as we know, have been two 28-foot mills built by William Sellers & Co. for the Westinghouse shops, Pittsburg, and a 30-foot mill at the Union Iron Works, San Francisco, Cal. The General Electric machine, therefore, will take work of twice the diameter of these and is much the largest and heaviest boring and turning mill ever constructed in this country and probably in any other country. It is hardly fair to make direct comparisons between this machine and the others, for it is a special machine, designed for special work, while the Sellers mills, at least, are tools of the regular type, relatively heavier, and adapted for work of relatively greater height above the table without the introduction of what might be termed "portable features." The cross-rail and saddles of the General Electric machine together weigh 155,000 pounds and of the Sellers mills 111,000 pounds. The rail of the former is about 38 feet long, made in two parts, and supported at the center as shown in Figs. 1 and 2. When unusually large pieces are to be turned the housings are moved back onto the projecting parts of the floor plate. The General Electric machine has a boring bar with independent drive and feeds, which can be used either for boring or slotting, and which greatly increases the scope of the mill. The following is an abstract of Mr. Riddell's paper:

When the excavation was made for this foundation a bed of quicksand was struck at a depth of 8 feet, which rendered it necessary to have a steel tank, 9 feet in diameter by 12 feet 9½ inches in height, sunk to keep back the sand and water.

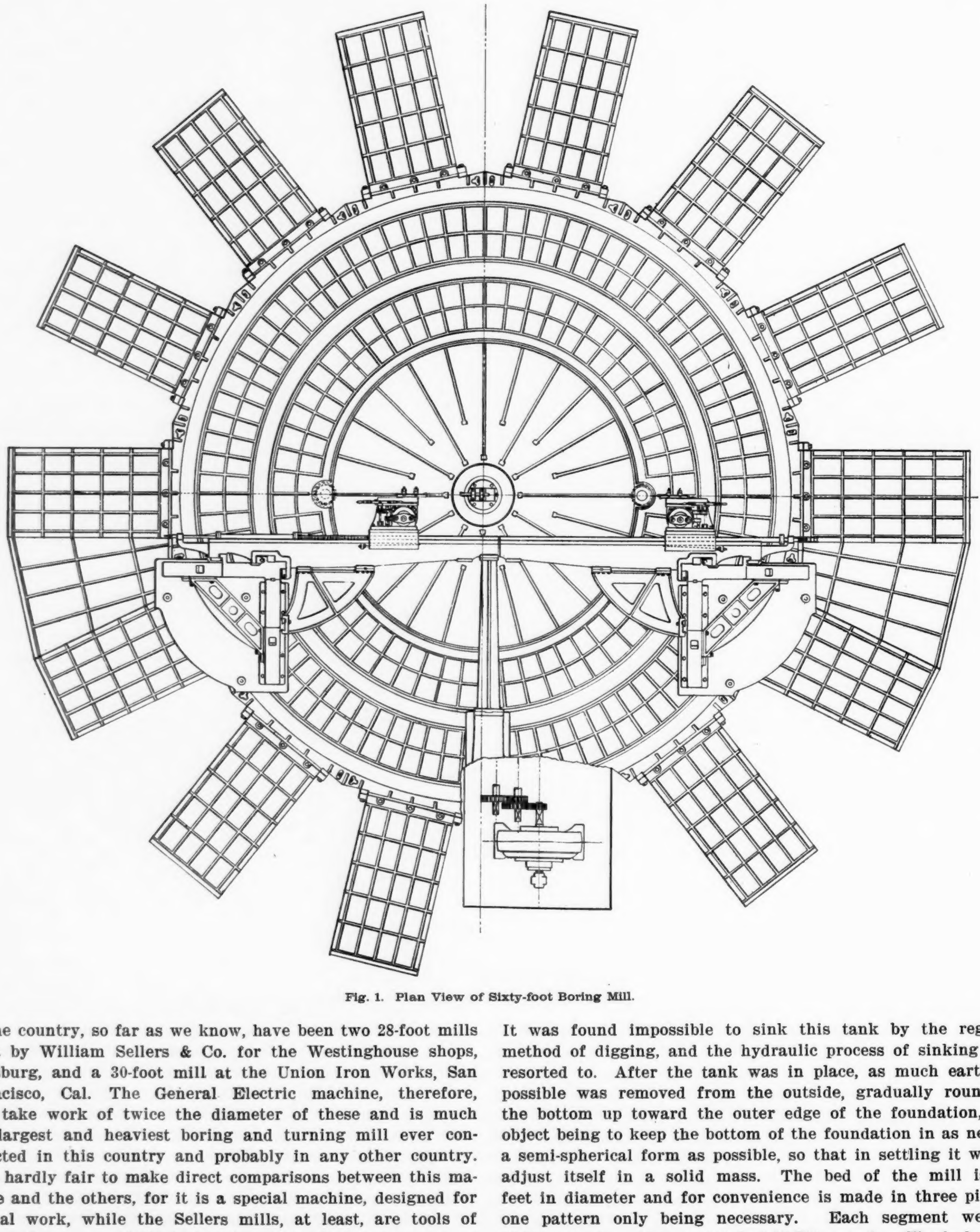


Fig. 1. Plan View of Sixty-foot Boring Mill.

It was found impossible to sink this tank by the regular method of digging, and the hydraulic process of sinking was resorted to. After the tank was in place, as much earth as possible was removed from the outside, gradually rounding the bottom up toward the outer edge of the foundation, the object being to keep the bottom of the foundation in as nearly a semi-spherical form as possible, so that in settling it would adjust itself in a solid mass. The bed of the mill is 20 feet in diameter and for convenience is made in three pieces, one pattern only being necessary. Each segment weighs 26,900 pounds, making a total of 80,700 pounds. The bed plate has two ways for the table to revolve upon, the center of outside way being 17 feet 6 inches in diameter and 10 inches

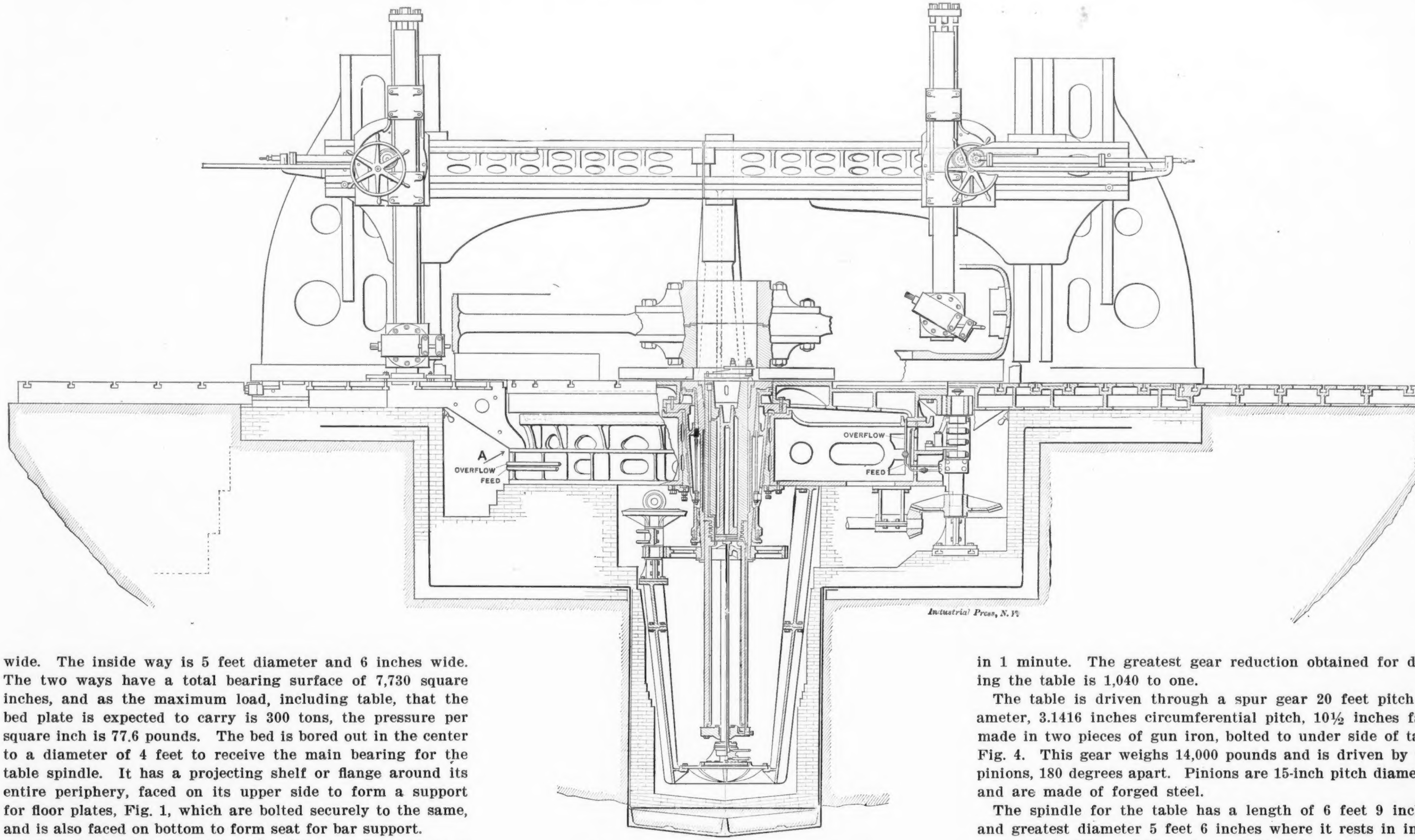



Fig. 2. Sectional Elevation through Boring Mill.

wide. The inside way is 5 feet diameter and 6 inches wide. The two ways have a total bearing surface of 7,730 square inches, and as the maximum load, including table, that the bed plate is expected to carry is 300 tons, the pressure per square inch is 77.6 pounds. The bed is bored out in the center to a diameter of 4 feet to receive the main bearing for the table spindle. It has a projecting shelf or flange around its entire periphery, faced on its upper side to form a support for floor plates, Fig. 1, which are bolted securely to the same, and is also faced on bottom to form seat for bar support.

Means are provided for oiling the table ways, by flooding or by pressure; the flanges at sides of ways form an oil well and are of sufficient height to allow a head of 2 inches of oil above surface of bearing at all times. (It may be of interest to know that 32 gallons of oil are required for this purpose.)

The table is 20 feet 4 inches in diameter, made in three sections, and weighs complete 78,900 pounds. It has a range in speeds from one revolution in 8 minutes to one revolution in 1 minute. The greatest gear reduction obtained for driving the table is 1,040 to one.

The table is driven through a spur gear 20 feet pitch diameter, 3.1416 inches circumferential pitch, 10½ inches face, made in two pieces of gun iron, bolted to under side of table Fig. 4. This gear weighs 14,000 pounds and is driven by two pinions, 180 degrees apart. Pinions are 15-inch pitch diameter, and are made of forged steel.

The spindle for the table has a length of 6 feet 9 inches, and greatest diameter 5 feet 6 inches where it rests in inner way of bed plate, and has a taper of ¾ inch per foot on main bearing, being 46 inches diameter at large end and 40 inches long; weight of same being 10,100 pounds. It is also bored out and splined at each end to receive bearings for the boring bar sleeve, and also adjustments for the same. Bearing for

table spindle is 48 inches outside diameter, 40 inches long, has babbitted pockets on inside for spindle bearing, bored to a diameter of 46 inches at large end with ¾-inch taper per foot. This bearing weighs 3,700 pounds. Immediately outside of revolving table there are 14 floor plates, making a stationary table of 44 feet diameter, each plate weighing 19,000 pounds, making a total of 266,000 pounds. Outside of this table there extend 15 plates radially, 6 feet wide by 10 feet 6 inches long, making a complete outside diameter of 65 feet. Each of these plates weighs 13,000 pounds, making a total weight for the 15 of 195,000 pounds.

The stationary table has two tracks upon its surface, center of inside track being 30 feet diameter and center of outside track 40 feet diameter, both 12 inches wide. The object of these tracks is to form an outer bearing for support on which boring tool heads rest when boring out large flywheels or frames, or forming outer bearings for frames or flywheels when they are being revolved by the table and are being turned on their outside diameters. These tracks are covered by a moving platform, to protect them from chips or dirt, and upon which the operator may stand.

The mill is equipped with a boring bar supported from beneath the table and designed for boring out work varying from one foot to eight feet in diameter by 16 feet long and is made to revolve in either direction by means of suitable gearing and reversing clutches. The bar is to have a hydraulic feed, and is built up of two cylinders, the upper 12 inches diameter, with 4 feet 8 inches travel and the lower 18 inches, bushed with copper sleeve to 17½ inches diameter, and with a travel of 8 feet. The piston of lower cylinder is stationary and mounted securely upon a hollow piston rod, which contains an internal tube that passes up through the piston to upper end of cylinder. Oil for upper end passes through this tube and for lower end through outside or piston rod tube and by means of port in the same near its connection with the piston passes into cylinder; thus, by admitting oil to under side of piston, the bar or cylinder moves downward and admission to upper side gives motion upward.

Should it be necessary to bore out a piece of work 24 inches or less in diameter, recourse is then had to the upper cylinder, where there is a double-acting piston, the rod of which is 8 inches diameter and forms the boring bar. Oil for operating this plunger is obtained as follows: A valve in bottom cylinder head is opened, the oil passes through valve up through pipe which is embedded in side of bar, up to and through inner head between upper and lower cylinders, thence to under side of top piston; the feed being controlled by the quantity of oil allowed to escape from upper side of piston. It will thus be seen that pressure is on both sides of both pistons at the same time, the pressure from pump being at the lower side of top piston and lower side of bottom piston, while the exhaust is on opposite side of pistons; this is to prevent any jumping effect of the bars in vertical direction when blowholes or other obstructions are encountered. By reversing the main operating valve, feed in opposite direction is obtained, the top of large bar and small plunger being made with taper sockets and key to carry boring heads. These boring heads are provided with suitable crossfeed slides to bore to diameter required. Thus when keyways are required, the same may be done by removing the boring tools and substituting slotting tools, and then by manipulating the main operating valve the bar may be given the cutting speed required and also have a quick return.

The bar support is made up of cast-iron segments machined and bolted together and suspended from the under side of the bed plate. A photograph of this is reproduced in Fig. 8.

The housings are constructed entirely different from the standard type of vertical boring mill. There are two large portable uprights 15 feet high, having one part of upright standing in same line as the cross-rail and the other standing at right angles thereto, both forming part of common base 9 feet square and tied together on the inside near the top by a very strong brace. The arm or cross-rail, Fig. 2, which has a vertical adjustment on standards, has bearings and gibs between rail and housings of ample width and length to secure alignment of the same. There is also a large bracket

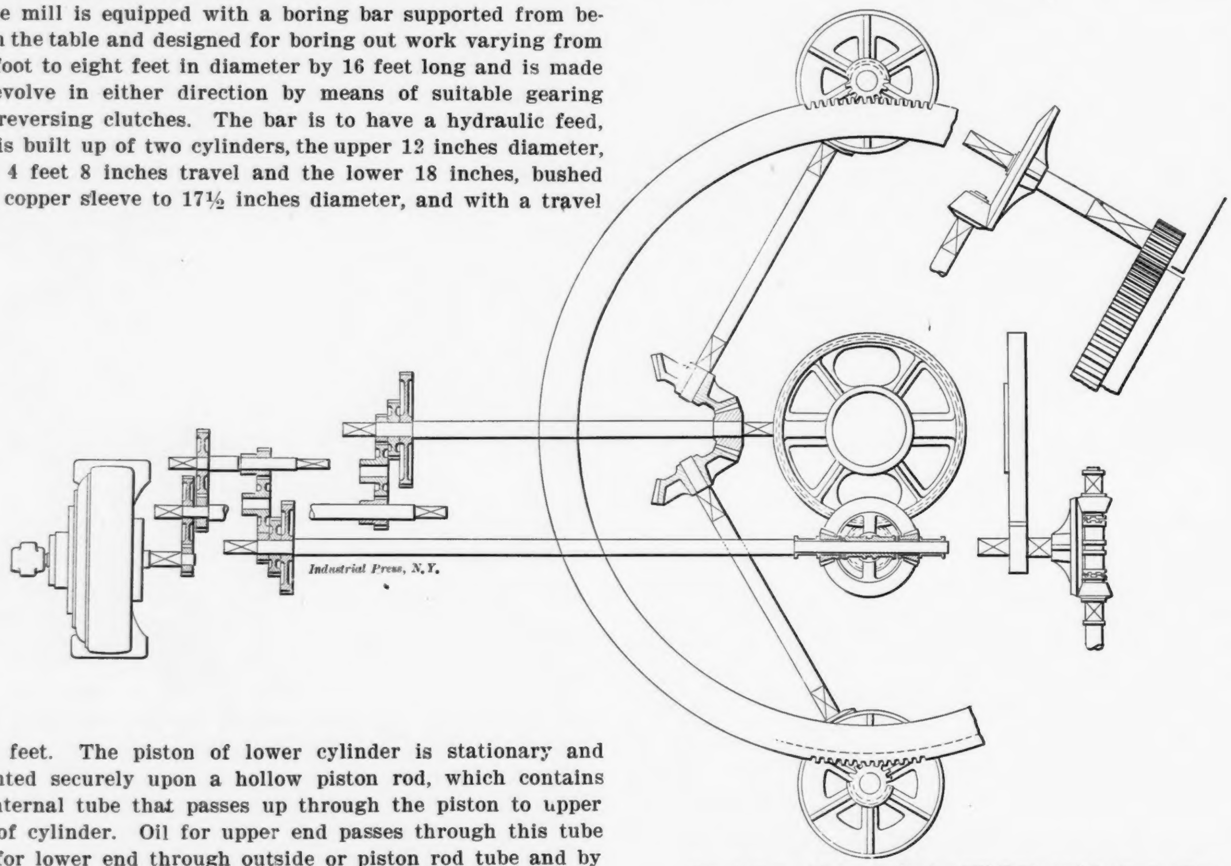


Fig. 3. Plan of Drive for Boring Mill Table and for Boring Bar.

at the back which slides upon back column of standard and a clamping device at end of rail, which passes across the face of housing, both of which when secured serve to prevent springing of the rail during operation. Additional support is given to rails where they join at the center, by means of a stationary stand and bracket extending out to and against the rail, as shown in plan of mill, these rails being of sufficient length to enable a minimum diameter of 12 inches and a maximum diameter of 28 feet to be bored and turned without moving the housings.

The design of cross-rail is peculiar in construction in having the lower face project 3½ inches beyond the upper part; this lower is 12 inches wide vertically and forms the main horizontal guide for saddle, one advantage being a double bearing to sustain the weight. The principal object is, however, greater accuracy and less liability for the saddle to oscillate, owing to the proportions of length to width of bearings, which is 12 x 42 inches, the usual proportions of large boring mill saddles being about square. The great width of rail to counteract the tool action is still retained.

Movement or feed of saddles along the rail is made by means of hydraulic mechanism, the piston and rod being

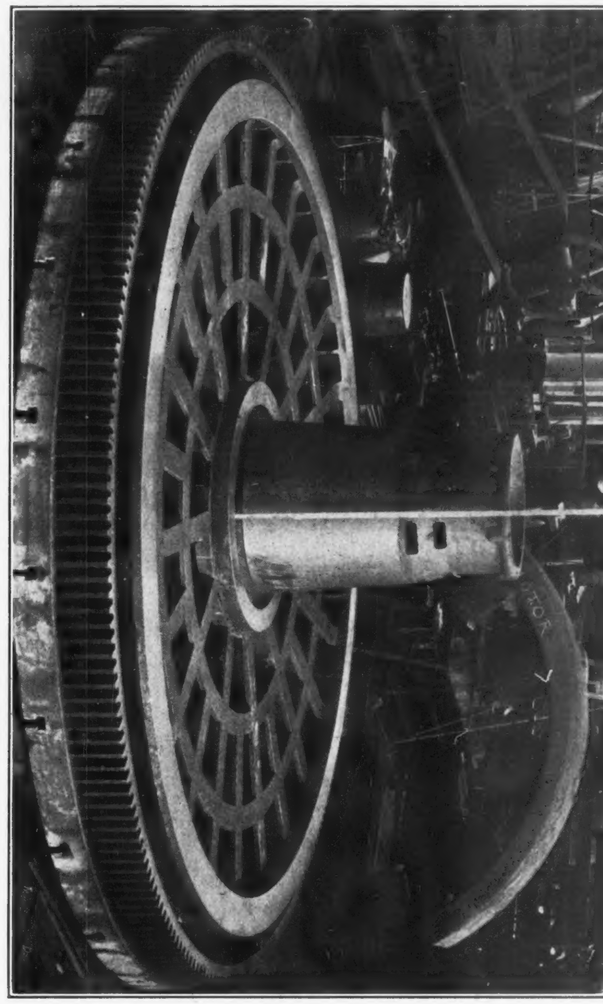


Fig. 4. Faceplate and Main Spindle.

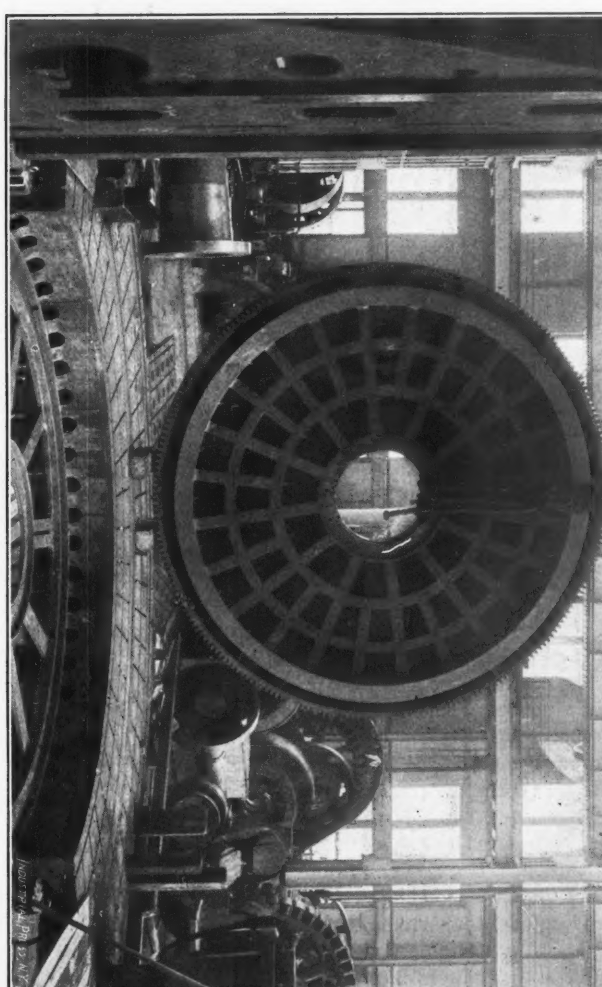


Fig. 5. Faceplate and Section of Bed.

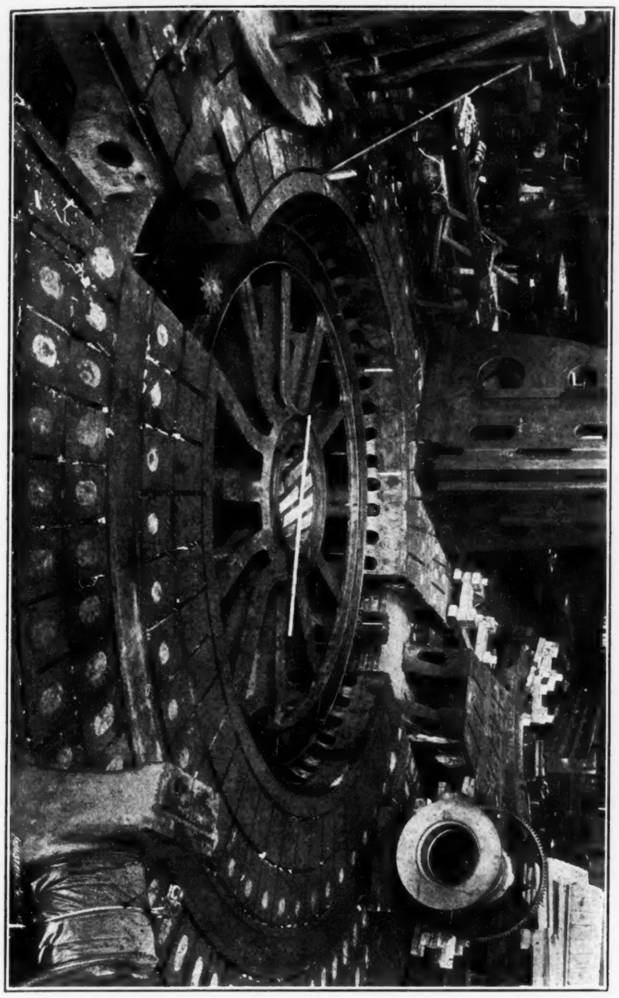


Fig. 6. Showing Bed, Bearings for Table, and Driving Pinions.

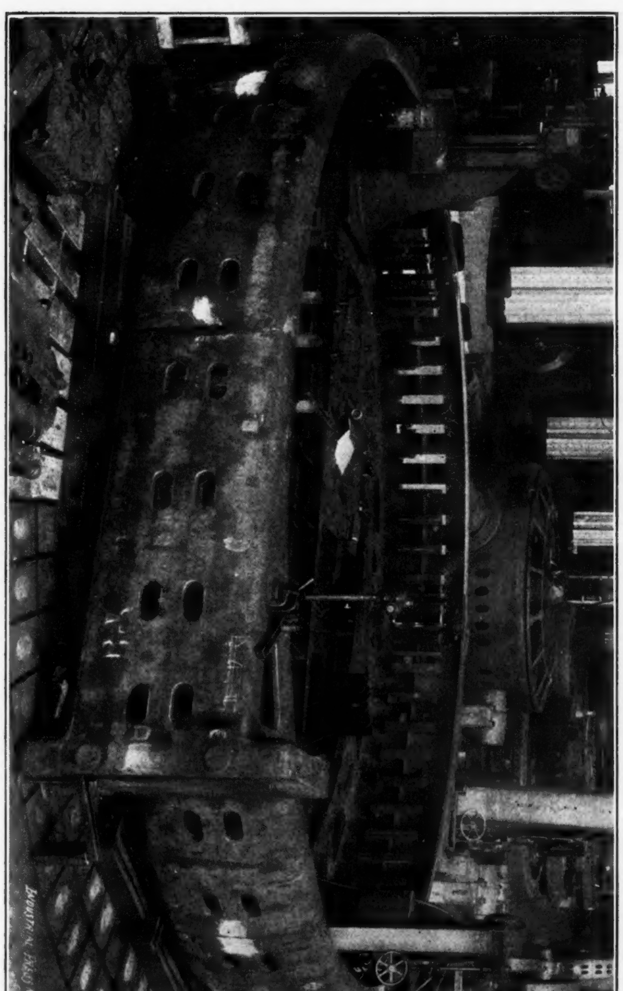


Fig. 7. Boring Mill at Work on Field Ring 34 feet in Diameter.

stationary and attached to bracket on outer end of rail. The cylinder is allowed to float, carrying on inner end a pair of gears proportioned two to one, which engages in two racks, the upper or stationary rack meshing with small gear, and the lower racks attached to saddle and meshing with large gear; this arrangement gives a motion of head equal to three times that of cylinder, pressure being admitted and discharged in the same manner as described for main boring bar.

The boring bars in tool heads—12 inches diameter by 15 feet long—are held in bearings on swivel plate, as on standard type of mill. This bar is bored out and fitted with a double-acting piston and hollow piston rod and cross head to which are attached two racks which serve as keys to prevent turning of bar and also for raising or lowering of bar or tool heads. The bar can be held in position as in standard mills, or can be lowered and clamped to floor when turning a piece of work. (See vertical section of boring mill, left-hand bar.)

The tool head is also provided with suitable device for raising or lowering bar by hand.

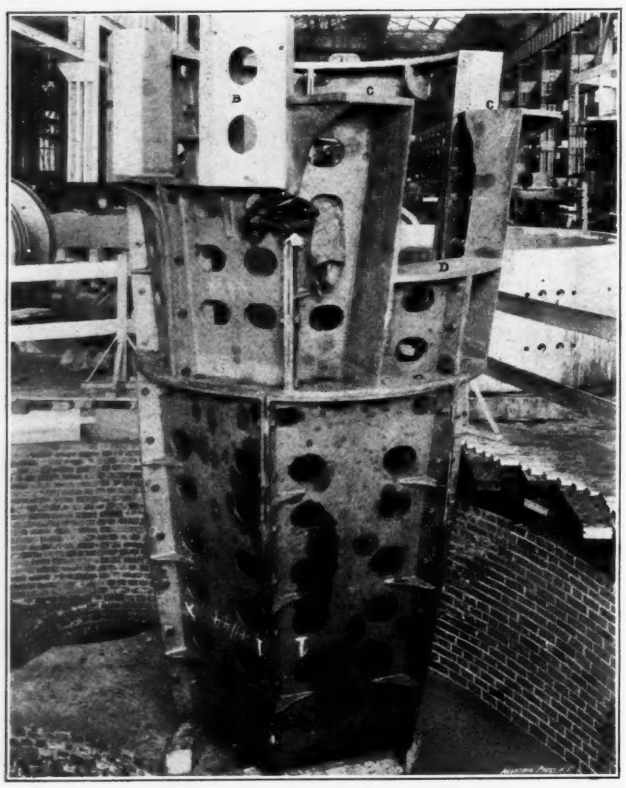



Fig. 8. Cast-Iron Support for the Boring Bar and Mechanism.

The tool head on bar consists of a cross-slide and swivel attachment, capable of being revolved around the bar by means of worm and wheel, and moved vertically along the bar by means of the two racks above mentioned.

The housings are supported by the stationary table and floor plates extending from the table to a diameter of 65 feet, being free to travel from a position close to table to outside diameter of plates, in which position they are capable of boring or turning work of a maximum diameter of 60 feet. Housing-rails, etc., weigh 155,580 pounds.

The power for driving this mill is obtained from a 50 horse power variable speed motor. This motor has a range of speeds of from 128 to 512 revolutions per minute inclusive, power being transmitted from pinion on armature shaft through train of gears to main driving shaft; Fig. 3, upon main driving shaft is a bevel pinion which meshes into two bevel gears on two shafts placed diagonally. Upon other end of this are two bevel pinions meshing in two large bevel gears, mounted upon vertical shafts, upon which are the two pinions for driving table gear. Motor is controlled by means of a portable controller, which can be carried to any point about the mill convenient for the operator. Fig. 7 shows the machine applied to boring a field ring 34 feet in diameter.

Net total weight of boring mill complete is 885,620 pounds.

* * *

## PISTONS AND PACKING RINGS.—6.

J. H. DUNBAR.

This installment will be devoted to the description and discussion of balanced packing rings; and to explain what they are, and who was probably the first to note their importance, I make the following quotation from Mr. H. D. Dunbar's patent of 1865:

"It also consists in so forming the central and packing rings that the outward pressure of the steam within the piston-head may be limited and regulated so as to reduce to the minimum the amount of friction between the packing and interior surface of the cylinder, consistent with a steam-tight joint."

Mr. Dunbar's packing was described in the first article of this series, which appeared in MACHINERY for July, 1902.

The best evidence I know of that cylinder wear is, to some extent at least, proportional to the pressure on the piston is that shown by an air-pump cylinder, such as are used on locomotives. When these cylinders get worn about a thirty-second larger at the ends than in the middle, they are rebored. I measured up a badly worn cylinder a few years ago, and then magnified the wear fifty times, and the diagram Fig. 1 is the result. The lines are approximately isothermal, showing that when air is being pumped, cylinder wear is about proportional to the pressure on the piston. For general service, narrow rings, and few of them, lessen cylinder wear, but this is offset by the increased pressure of the rings against the cylinder walls and the difficulty in applying oil. A balanced packing ring is needed. I note a few.

Downie's packing for marine engines is of the type under discussion, and was shown in MACHINERY, January, 1903. It consists of a pair of snap rings, wedge shape in cross section, in a single groove which clamps the rings as they expand and prevents their otherwise excessive pressure against the cylinder. Fig. 2 shows Downie's packing as it appears in the January, 1903, issue, with the addition of holes *a a* through the flanges. The cavity *B* connects the joints and steam can flow in at one and around the piston to the other, and out. This leakage will be small, and if in the high pressure cylinder of a compound engine is not lost.

It is assumed that in Downie's packing the rings are placed in the grooves with their joints 180 degrees apart; are uniform in cross section (not eccentric); that their joints are uncovered, so that, say half as much pressure will be kept in cavity *B* as there is on the piston; that the ring and cylinder wear is to the ring and groove wear as 10 to 1; that the piston is at the top of the cylinder with the rings just comfortably in touch with it and their groove, and that all are of uniform temperature. We now admit steam at 200 pounds pressure to the top of the piston, with the result that the cylinder expands through the effects of pressure and temperature. Steam then enters cavity *B*, expanding the piston by its heat and forcing the rings to the cylinder and tight in their groove. At one-fifth stroke, steam pressure is cut off, and the cylinder contracts during the other four-fifths, and forces the rings to contract as much (except that which wears off) as the cylinder expanded owing to the pressure of the steam; so that the rings by the time they get to the bottom of the cylinder, bear the same relation to it and to the piston that they did at the top, except that they are a little nearer worn out. It will be noted that during this single stroke the rings were first forced out, then in, making two groove-wears to one on the cylinder. It will also be seen that this alternate out-and-in action of the ring will tend to wear the cylinder "barrel shape," and with constant pressure, point of cut-off and lubrication and perfect piston alignment, an ideal piston efficiency may result. If the groove wear should exceed the cylinder wear, the rings may be placed with joints coincident in their groove, so they will contract and expand as a unit. In any other position, they will wear on each other. With this packing there can be no groove wear due to impact, for the slight movement of the rings would only result in varying their degree of tightness. The pressure on the

top flange of the piston will tend to close the groove, and tighten the rings in it. I do not see any reason why we may not make use of this condition and hold the rings in their grooves, with practically a constant pressure against the cylinder, by making slightly flexible flanges, and proportioning the ring so the radial steam pressure on it will be balanced by groove friction. A piston of this kind is shown in Fig. 3. It will leak at the joints of the rings, and after the point of cut-off, as the cylinder pressure is reduced, it contracts, and the ring is forced to contract, just the same as Downie's does, the principal difference being that only one ring is tight at a time, and as long as they do not stick in their grooves, they will make the piston practically steam-tight. I do believe, however, that rings held in their grooves as in a vise are more apt to score the cylinder than if free.

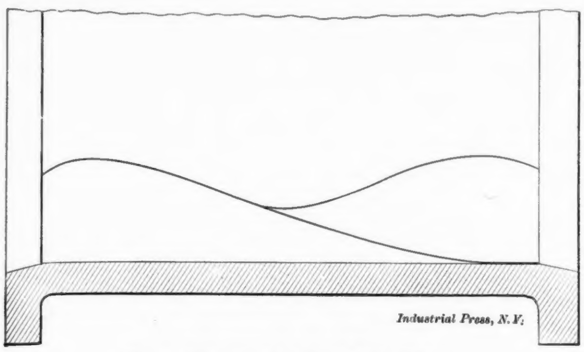



Fig. 1. Diagram showing Piston Wear.

The next on my list is another English piston for marine engines, shown in Fig. 4, which the editor of MACHINERY clipped from the *Mechanical World* and kindly sent me. Its inventor, Mr. Berry, describes it as follows:

"*B* is a junk ring, loose on the piston body, and adjustable diametrically with setscrews *d*. It is also provided with springs *D* which force the packing rings *A A′* apart vertically. The latter are rings of rectangular section, whose ends are forced apart by springs *S* placed under the brass-joint pieces *M*, as shown. The ends of the ring are cut on an angle as usual, and are normally ⅛ inch apart. In order to prevent the steam finding its way to the back of the ring, care has been taken to block the water grooves at *a*, *a* and *b*, *b*." This packing is simple in construction, and has proved very efficient in practice. In support of this latter claim we were given an opportunity to closely examine the interior of the high-pressure cylinder, in which the tool marks were very plainly visible, although no lubricant had been used, and the vessel had steamed from Liverpool to Japan, thence to Australia, and thence to Europe, at an average piston speed of 650 feet per minute." Tool mark credentials may be of some value in determining cylinder wear, but they do not carry any evidence that the piston was steam-tight. It would be interesting to know if the tool marks were also visible on the packing rings, at the time the cylinder was examined. It will be remembered that Mr. Berry cuts his packing rings in sections, and sets them out to the cylinder with springs *S*, and out to the flanges, with springs *D*. Now I take it that springs *D* are stiff enough to resist the steam pressure tending to force them in an up-and-down direction; and as the joints are covered, there is no chance for steam to get under and force them out. Under such circumstances, if springs *S* are stiff enough to be relied on to keep the rings out, they are very objectionably too stiff when the cylinder has to set the rings in. Suppose that springs *D* require 100 pounds per inch of circumference of the rings to set them out, then it is plain that it will require 200 to set them in. In thinking this matter over I conclude that it would be exceedingly dangerous to run a piston dry in a cylinder, if its rings, or any other part could touch it with an appreciable pressure. I have heard of low-pressure pistons, say thirty years ago, being run without oil continuously without injury, but Mr. Berry's is the first high-pressure, that I have known of. There is a considerable difference between the way Mr. Berry clamps his rings in their grooves, and the way they are held in Fig. 3. It will be noted that the spring *D* produces nearly constant side pressure on the rings, while in Fig 3 it varies as the pressure on the piston, and when on the exhaust side of it, they are very nearly free to expand.

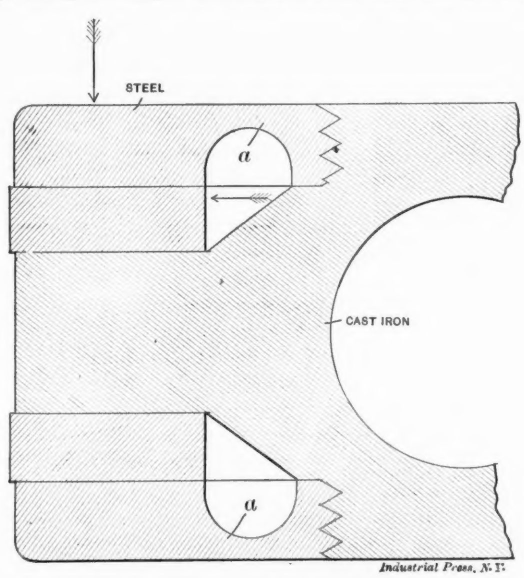



Fig. 3. Piston with Flexible Flanges.

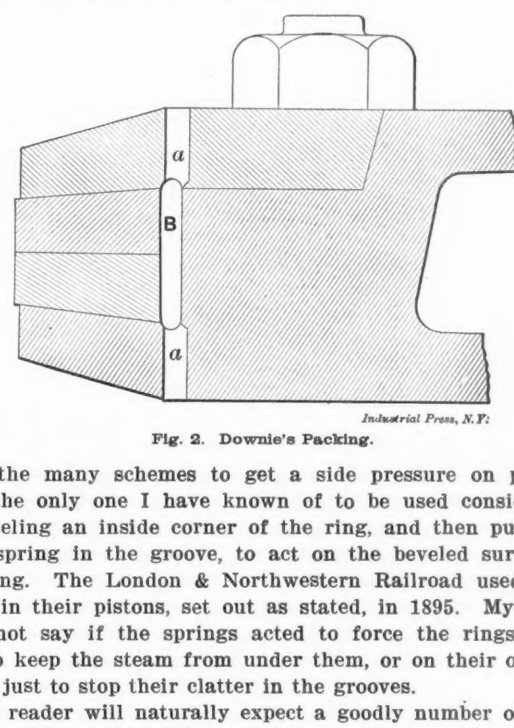



Fig. 2. Downie's Packing.

Of the many schemes to get a side pressure on packing ring the only one I have known of to be used considerably is beveling an inside corner of the ring, and then putting a wire spring in the groove, to act on the beveled surface of the ring. The London & Northwestern Railroad used brass rings in their pistons, set out as stated, in 1895. My report does not say if the springs acted to force the rings apart, and to keep the steam from under them, or on their opposite sides, just to stop their clatter in the grooves.

The reader will naturally expect a goodly number of originalities in anything that Professor Sweet designs, and I want to say right here, that the pistons of his Straight Line engines (a blueprint and catalogue of which he has kindly sent me) are a case in which the expected happens. I will begin by describing his packing ring, and that part within quotation marks is what he says of it.

On page 4 of the Straight Line Engine Company's catalogue we find that "limited expansion piston rings were conceived about 1884." I make this statement to show that Professor Sweet was among the first to see that steam would get under packing rings, if there were no special ports for that purpose. Still there are inventors scheming for some new way to give the steam a better chance to set the ring out, evidently believing that "steam-tight" means all the pressure on the ring that the cylinder will stand without bursting. It is to be hoped that the correspondence schools will show their scholars just how a packing ring packs, in a much clearer manner than the average text-book.

To counteract the internal steam pressure, Professor Sweet connects the ends of his rings with a tie piece, and to get the maximum and also uniform groove surface he makes the edges of his rings concentric and very materially adds to their uniform elasticity by making the central part eccentric, all as shown in his blueprint, Fig. 5. "The joint in the ring is held on the bottom of the cylinder by the pin

in the tie piece and the steam is prevented from leaking by the bull ring which carries the load, shutting off the gap. The steam gets under the ring of course, but cannot force it out, owing to the limit tie piece. One unlooked-for favorable feature developed when we put these rings in practice. When starting the engines the rings have to open and close at the ends as they go in and out of the cold end of the cylinder. This hammers the hooks away very slowly, so that this just about compensates for the wear on the rings and it is seldom necessary to remove the tie piece and file away the hooks." This is certainly a fortunate condition, to have the hooks hammer or wear away just fast enough, making the length of the tie piece automatic, and is not at all unreasonable if we look at it rightly. It seems to me that an unmentioned source of wear on the hooks would take place when the tie piece was sustaining half the internal pressure on the ring. For the line of stress in the tie piece is above the neutral surface of the ring, which will tend to throw the ends at the joints down; and when the exhaust is opened at that end of the piston, they come up to their original position, causing a very slight rolling wear on the hooks twice to a revolution of the engine. No leakage will take place by this up-and-down pulsation of the points of the ring, for the bull ring will cover any gap within its arc of contact with the cylinder. The points of the rings, too, would soon wear to accommodate the spring, due to the pull on the tie piece. The reader will note that the faces of the hooks are not parallel, and that the way the tie piece is dowelled, if the bull ring wears faster than the packing ring, the tie piece is lengthened thereby. Perhaps there is some objection to a vertical stem on the tie piece passing up through the horizontal flange of the piston, forming a dowel pin, that I do not see. If there is, I beg pardon for making the suggestion.

The Straight Line engine cylinders are bushed, and I judge from the illustrations in the company's catalogue, that the bush and packing ring are of about an equal thickness, so that these two parts will expand about alike with both temperature and pressure. So there is nothing to prevent the packing ring from being just a touching fit with the cylinder at all parts of the stroke. Under such conditions, the ring wear would be the least that is possible, consistent with steam-tightness of piston, and while the hook wear (four surfaces) must be at least three times the ring wear, the hook surfaces may be proportioned, from experience, to just meet the requirements. If the hook wear should be too rapid, it would increase the ring pressure on the cylinder, and consequently increase their wear, and react by decreasing the hook wear. If, however, the ring wear should be too fast, there does not seem to be any remedy but to ease off the hooks. It seems to me that it would be advisable to test this piston occasionally for tightness; and while taking off the cylinder head and putting steam behind the piston is a good way, an easier way is to open the cylinder vents and blow the air out of it with steam when it is cold, then close the vents and throttle, and note by an indicator or vacuum gage attached to that end of the cylinder, how much vacuum is produced by the steam condensing. Of course this is only an inferential test, and to be of any value the vents, valve and throttle must be known to be tight.

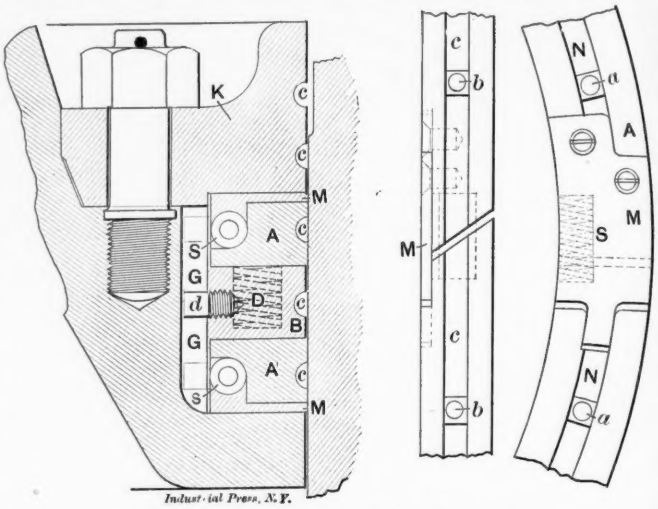



Fig. 4. English Piston for Marine Engines.

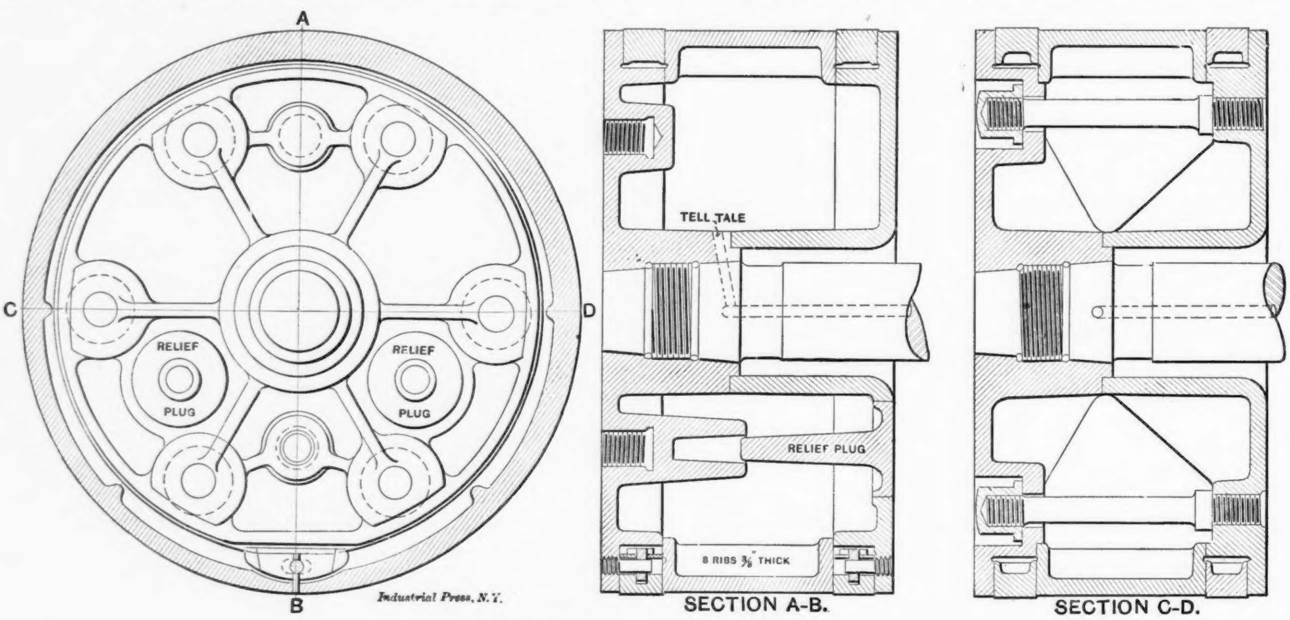



Fig. 5. Prof. Sweet's "Straight-Line" Piston.

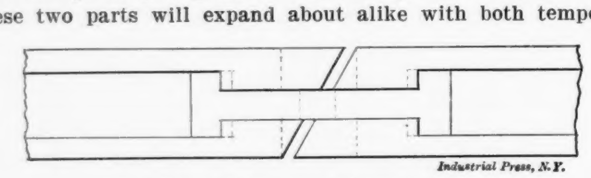



Fig. 6. Tie-piece on Inside of Ring.

In general design, Professor Sweet's piston is in a class by itself, as the reader will see by a glance at it. After describing his packing ring, he says:

"You will notice some other things about the piston—that it is light, that when it wears there is nothing to renew but the bull ring, that there are no cap screws to work loose and cause a smash-up, that the bodies of the studs are turned down so that the nuts never get loose on account of the elasticity of the studs, that the grooves are undercut so that the wearing surface in the groove is the same width as the wearing face of the ring, etc." Another feature of this piston is its relief plugs. In case too much water gets mixed with the steam, these plugs are forced into the piston, affording ample room for the water. The plugs are forced in the piston till they will resist a pressure of 200 pounds per square inch. When a plug is blown in, the engineer is notified by water flowing through the tell-tale, i e.,

a hole through the piston rod communicating with the interior of the piston. In reply to an inquiry, I learn that there is no partition in the piston, and that it has only happened once that the plugs at both ends of the piston were blown in at a time; then a half hour's shut-down was required. When the plugs at one end only are blown in, the engine is run just as though nothing had happened till an opportune time for replacing them.

There is one very good feature about these plugs; they don't bespatter everything in their cone of dispersion, as outside plugs do when they go off, and combined are big enough for any emergency, while usually single plugs are not. The Professor calls this his pop piston, and says "that the best thing about it is that it works when there is an occasion, which may be soon or never."

* * *

## A. S. M. E. PAPERS

### PRESENTED AT THE SARATOGA CONVENTION, JUNE 23 TO 26.

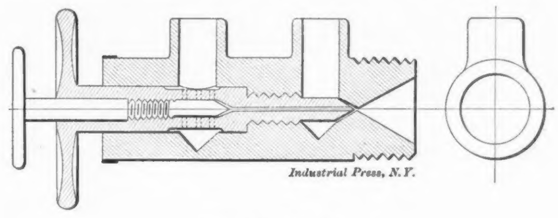
As we go to press the sessions of the summer meetings of the American Society of Mechanical Engineers are in progress at Saratoga. Elsewhere in this number two of the papers presented are reproduced nearly in full; one is summarized in the data sheet, and below are brief paragraphs upon the balance of the papers.

One of the most exhaustive of these was by Prof. C. H. Robertson, Purdue University, upon tests of a 12 horse power gas engine. This paper contains a record of tests by several students in the preparation of their graduating theses during a period of six years. The tests were designed to determine the effects upon the gas engine of changes in speed, load, point of ignition, ratio of gas to air, and jacket temperature. It is obviously impossible in the space at our disposal to give an adequate review of a paper of this character, in which extended detailed results of many tests are grouped together, and the same holds of several other papers to which we shall but briefly refer. Prof. Robertson's conclusions may be summarized as follows: Increase in speed from 150 to 300 revolutions results in increase in amount of gas per explosion, a proportionately less increase in mean effective pressure, and an increase in explosions per minute at constant power; a decrease in efficiency of 25 per cent., due in part to an increase of 2.20 horse power absorbed by friction; and a marked decrease in the per cent. of heat absorbed by the jacket and an increase in the per cent. exhausted and radiated.

With respect to the load, an increase from 0 to 10 horse power decreases the M. E. P. from about 94 to 82, and an increase in load from 2 to 10 horse power causes an increase in mechanical efficiency from about 37 to 78 per cent. In addition to these results there are conclusions with respect to the proportions of gas and air used, most desirable point of ignition and best jacket temperature. From the standpoint of the indicated horse power, the lowest gas consumption and the highest thermal efficiency are secured under the following conditions: Ignition between normal and late, jacket temperature, the lowest used, or 90 degrees; speed, the lowest tried, or 150 revolutions per minute; brake horse power, at about .6 the normal capacity of the engine.

There are two other gas engine papers, one upon an engine using gasoline and kerosene as fuel, by H. F. Halladay and G. O. Hodge, and "A Method of Testing Gas Engines," by E. C. Oliver. The first of these comprises the results of an exceedingly interesting series of tests on an Otto gas engine at the Clarkson School of Technology. The engine is nominally rated at 15 horse power and is designed for either gas or gasoline, a change of two valves being all that is required when desired to change from one fuel to the other. In order to use kerosene fuel, however, additional apparatus was required by which the oil could be sprayed into a heated chamber where it could be vaporized and the vapor superheated sufficiently to prevent the oil vapor condensing and depositing on the cooler walls of the ports and valves of the engine. It was found that if the vapor reached a temperature lower than 575 degrees it would at once condense. The temperature of vaporization of the kerosene was about 380 degrees and it was superheated on an average about 240 degrees.

The nozzle employed in spraying the kerosene is shown in the sketch herewith, *A* being the kerosene connection and *B* the connection with the compressed air. The nozzle delivered into a horizontal pipe under which Bunsen burners were placed. The most satisfactory conditions for the use of kerosene were found by adjusting the supply of the mixture of air and kerosene simultaneously with the regular air admission to the engine cylinder, so that the exhaust was smokeless. The heating value of the two fuels was 20,296 B. T. U. for the gasoline and 19,282 B. T. U. for the kerosene. The price of the former was 14½ cents a gallon and of the latter 14 cents. The rate of consumption was the same for both fuels at 4.5 brake horse power; under light loads the gasoline was the more economical and under heavy loads the kerosene.




Vaporizing Nozzle.

Averages of all the tests show that with kerosene the per cent. fuel converted into useful work was 16.5; while the per cent. gasoline converted into useful work was only 12.5. These results appear very favorable to the kerosene; but this is undoubtedly due in part, at least, to the fact that the kerosene vapor is superheated by the application of outside heat, which adds to the efficiency of the vapor.

The paper by Mr. Oliver upon a method of testing gas engines discusses a system of tests worked out by the author in the University of Illinois, and deals chiefly with the determination of the quantities of air and gas used, and the temperature of the exhaust gas at atmospheric pressure—quantities all difficult to calculate or measure by ordinary means.

---

The United States Army Gun Factory, Watervliet Arsenal, N. Y., was described by J. M. Scheele. Watervliet Arsenal was established in 1813 as a military establishment and field carriages and leather equipment were the most important products. A shop built in 1887 is now used for the manufacture of field and siege guns, which is a distinct department from the seacoast gun shop. The latter is a building 1,000 feet in length, with two wings, and equipped with 40 heavy lathes classified as gun lathes, jacket and hoop lathes, which are capable of handling guns up to 16 inches in diameter.

All boring, reaming, turning and facing operations of the tubes, jackets, large hoops and the assembled guns are performed in these lathes; short hoops are usually turned, bored and placed in regular boring and turning mills or in cylinder boring machines. Special machines are also available for the principal remaining operations on the gun, such as rifling the bore, threading and slotting the breech.

A large number of modern standard machine tools are used for making the breech mechanisms fitted to each gun. The metal employed in gun construction is low carbon steel, melted by the open-hearth process and cast into suitable ingots at the works of the manufacturers. The forgings as received at the army gun factory are tempered, annealed, and rough-machined all over. Approximately twenty per cent. to twenty-five per cent. of metal is removed by the various tools and appliances at the gun shop for producing the finished guns.

The machinists and all skilled mechanics are employed under the system of local civil service board, the civil service law being carried out strictly within the provisions of the government requirements, thus applying the merit system to all applicants.

Records are kept of each employee, which are examined from month to month. This method enables the board to investigate the employees' standing and efficiency, also to recommend an increase of wages and promotion to the next higher class for those who have proved themselves worthy.

The promotions are generally made quarterly. The machinists are divided into four classes—namely, the special class, the first, second and third; their wages ranging from \$2.72 to \$3.28 per diem for eight hours work, foremen not being included in these classes.

To each employee who has served not less than one year is granted fifteen days annual leave with pay, and all employees are paid for the general holidays.

What is, perhaps, the paper of greatest current interest is a description and test of a 400 K. W. turbo-generator of the Westinghouse-Parsons type, installed at the Yale & Towne plant, Stamford, Conn. The turbine end of this unit has been entirely satisfactory during the year or more that it has been in operation; it has required no renewals or repairs, and the bearings show no appreciable wear. But one-half gallon of oil is required per week. The only trouble that developed with the steam end was its liability to shut down when running from three-quarter to full load if by any chance the vacuum became destroyed. A device for automatically preventing this, however, is to be adopted.

The electrical end of the unit was not so satisfactory. At first the generator field gave trouble and was replaced and the new field proved defective and burst—difficulties that do not affect the turbine question.

Answers are given to a number of questions, some of which are briefly as follows: It does fulfill the guaranteed economy; the noise is not excessive nor disagreeable; the continuity of operation is satisfactory; the exhaust can be used for heating purposes; it can be changed from condensing to non-condensing with ease, and this is done daily; the exciter should be driven by an independent engine; the cost of such a generating outfit is ten to fifteen per cent. less than an equivalent reciprocating engine; the vibration is not at all excessive. The paper closes with a number of boiler, economy and motor tests.

There is no doubt that the alternating current is gaining in favor over the direct current in electrical distribution and would make more rapid strides were it not for lack of speed control features. A paper by W. L. Slichter upon alternating current motors for variable speed is therefore of considerable interest.

The speed of an alternating current motor may be controlled in a number of ways:

(*a*) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary.

(*b*) By varying the resistance in the secondary circuit.

(*c*) By changing the connections of the primary in a manner to change the number of poles.

(*d*) By varying the frequency of the applied voltage.

The characteristics of the alternating current motor are very similar to those of the continuous current shunt motor —that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about 15 to 20 per cent. below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects.

The one exception to this last rule is the effect of the resistance (or losses) in the secondary (usually the rotating) member.

The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops.

Of the various methods of speed variation, the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc.

Mr. A. H. Eldredge, an occasional contributor to MACHINERY, has two short papers, one describing a hot well of special design, which also served as a very efficient oil extractor; and the other on the desirability of positive governor drives for Corliss engines. The first shows that a hot well, properly proportioned, will extract the oil discharged in the exhaust, through the condenser, on the principle of the oil rising to the surface and draining off at the top, while the feed water is pumped out at the bottom. The second paper describes two governor drives, one by means of shafts and gears and the other by means of a Morse rocker chain, which had displaced unsatisfactory belt drives and caused the engines to run much better than they had previously.

Prof. D. S. Jacobus summarizes the results of tests on a Rice and Sargent cross-compound engine, having cylinders 20 and 40 inches by 42 inches stroke. The clearance for the high-pressure cylinder was 4.7 per cent. and of the low-pressure, 7 per cent. There was a reheating receiver and the cylinder heads were jacketed. The water consumption per indicated horse power per hour varied from 12.10 pounds at 627.4 horse power to 12.75 pounds at 1,004.3 horse power. At 491.4 horse power the water consumption was 13.92 pounds, and at 339.7 horse power it was 14.58 pounds. These figures represent the total water consumption, including that used by the jackets and reheater coil.

The balance of the papers are either somewhat out of the field of MACHINERY or else are of such a character as not to be susceptible of condensation in the form of an abstract, and their titles are given herewith: A Drawing Office Equipment, by John McGeorge, of the Wellman-Seaver-Morgan Plant, Cleveland; Test of a Hydraulic Elevator Plant, by R. P. Bolton; Rational Train Resistance Formula, by John B. Blood; Turbine Flow Recorder (already described in a previous number of MACHINERY), by Chas. M. Allen; Some Data on Hoisting Hooks, by John L. Bacon; Strains Produced by Excessive Tightening of Nuts, by A. Bement; Indicating Anglemeter, by C. E. Sargent; Graphical Daily Balance to Manufacture, by H. L. Gantt; Shop Management, by Fred W. Taylor; The Machine Shop Problem, by Chas. Day; Experiment Boiler of Ohio State University, E. A. Hitchcock; Mechanics of Air Brake Systems, H. G. Manning; Comparative Oil Tests, W. F. Palish; Test of Eight-Foot Fan Blower, by R. P. Bolton.

* * *

A correspondent to the *Scientific American* announces a wonder of wonders, being no less than the discovery of how to always have a sharp razor. His plan is to always strop his razor while as hot as it can be made by dipping in boiling water, and to use it when cold. The theory advanced is the somewhat fanciful one that the contraction of the edge makes it appreciably keener. In this connection it may be mentioned that it is considered bad practice to place keen-edged tools like razors, surgical instruments, etc., in boiling water for any great length of time as the edge is thereby dulled. Therefore, never boil your razor.

# ENGINEERING REVIEW.

## CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The new Fisk street power station now building in Chicago for the Chicago Edison Station, is planned for 14 Curtis vertical steam turbines direct-connected to General Electric generators of 5,000 kilowatt capacity each. The present structure is being built for only four turbines, but the extension for the other ten can be made in harmony with it when required, or if the turbines are found unsuitable, a slight change will permit the installation of reciprocating engines. The boiler house is arranged in units, each containing eight Babcock & Wilcox boilers to supply two turbines, having 5,000 square feet of heating surface and carrying a pressure of 175 pounds. The steam is to be superheated to 150 degrees above that normal to its pressure. The nominal boiler rating for each turbine is 4,000 boiler horsepower.

A recent computation has placed the total aggregate power of steam turbines in use or under construction or ordered in different parts of the world at over 500,000 H. P. Of this total the major portion is used or to be used for the driving of dynamos, alternators, or other electrical machinery, while the next in importance is marine engines. The Metropolitan District Railway Co., London, England, have recently contracted with the British Westinghouse Electric & Mfg. Co. for four turbo-alternators. Each of these machines is designed for a normal capacity of 5,500 kilowatts, but will be capable of carrying an overload of 50 per cent., giving for each unit a maximum output of 8,250 kilowatts, or about 11,000 E. H. P. These turbines will be not only the largest steam turbines ever made, but also the most powerful single cylinder engines of any type whatever in the world. Very few multiple cylinder engines existent have greater power. Notwithstanding the enormous power they will develop, the dimensions of these engines are only 29 feet in length, by 14 feet wide, by 12 feet high, the over all length of turbine and alternator being 51 feet 9 inches. The steam pressure will be 165 pounds per square inch, and the speed 1,000 R. P. M.

The *American Shipbuilder* describes what will be the largest river steamboat in the world—the *C. W. Morse* now building at the shipyard of Harlan & Hollingsworth, Wilmington, Del., for the People's Evening Line, to ply on the Hudson River between New York and Albany. The new vessel will closely follow the lines of the *Adirondack*, but will be larger in every way, the length being 430 feet and breadth over guards, 96 feet. The hull will be constructed of mild steel as will be the deckhouse up to the saloon deck. The motive power will be a W. A. Fletcher & Co. walking-beam surface condensing engine of 4,500 horse power connected to Morgan feathering paddle wheels. The fittings of the staterooms and saloons have many up-to-date features that will enhance the beauty and elegance of a floating palace, and conduce to the comfort and pleasure of passengers. An entirely new feature on Hudson River boats will be introduced on this vessel, and that is outside ventilation for all staterooms. All the staterooms will be furnished with iron and brass bedsteads which, in the better rooms, will be double width, giving, with the other appointments, all the comfort and luxury of a first-class hotel. The new vessel will be launched in June and will be ready for service with the opening of the season in 1904.

In a paper read by Alex. Dow, before the National Electric Light Association, at Chicago, May 26-28, a comparatively new means of utilizing the exhaust steam of electric light and power stations, was referred to; that is to evaporate brine, salt thereby being made a by-product. In Michigan near Detroit exist extensive salt beds and this condition has led to the innovation outlined in the paper—the manufacture of salt as an adjunct to a power station. The possibilities of this scheme seem to promise more than the use of exhaust steam for heating. When used for the latter purpose there is a demand for it only during the winter months; the salt making may go on the year round, and if any emergency arise its use can be suspended without raising a public clamor. It is pointed out that if electric power can be made sufficiently cheap, and the cost during the daylight hours be regulated to stimulate a demand for it at that time and reduce the peak of the load, there will undoubtedly be in almost any community, especially one like Detroit, a demand for power throughout the whole twenty-four hours. Now a salt-making plant can be profitably utilized to absorb the heat in the exhaust steam and the returns from the salt sold will, it is claimed, wipe out the cost of the coal.

In a paper read by A. D. Williamson on the application of electricity at the works of Vickers Sons & Maxim, before the Institution of Electrical Engineers, May 7, the author discussed the problem of variable-speed motors. He said that the subject had received much attention within the past few years, and that there is now no difficulty in making efficient motors that can be varied with a range of 3 to 1 by varying the field excitation. A range of 3 to 1 seems to be about the most economical one for motors of fair size, say, from 250 to 750, or 300 to 900 revolutions per minute for motors from 5 to 30 horse power. The firm above mentioned are building motors which work sparklessly with fixed brushes with a speed variation of 3 to 1. In connection with this portion of the paper a novel application of the variable-speed motor was mentioned which is used in the same works. A portable vertical planer or slotting machine is driven by a 5 brake horse power motor with a range of speed from 300 to 900, the motor being attached direct to the machine. On the cutting stroke the motor runs at its slowest speed, and at the end of the stroke, the length of which is easily adjusted to suit the work, the motor reverses automatically. As soon as the reversal has occurred a resistance is automatically inserted in the field winding, quickly raising the speed to 900 for the return stroke. At the end of the quick return stroke, immediately before reversal, the field resistance is short-circuited, providing a strong field for reversing in, and the motor reverses and makes its slow cutting stroke, the cycle repeating itself. The insertion and removal of the field resistance necessitates a special form of switch, which is provisionally protected and cannot at present be described in detail. The arrangement has been in use for some time successfully, and it is anticipated that it will be of great use in driving many types of reciprocating machines. In actual practice it is found that this method of driving is very economical and possesses advantages over the usual belt reversing drive, as the excess current at reversing can be reduced to a negligible quantity.

### COOLING AN AUDITORIUM BY AIR PASSING OVER ICE.

As the hot weather comes on, any method by which sweltering humanity can keep cool when the mercury is in the nineties, must be of interest, especially if they must attend crowded entertainments. A paper was read by John J. Harris at Atlantic City, N. J., before the American Society of Heating and Ventilating Engineers in which he described a method by which an auditorium at Scranton, Pa., has been cooled during the commencement exercises for the past two years, by forcing air over racks of ice. The moisture was controlled by the use of calcium chloride. The auditorium which has a seating capacity of 900 was kept at a temperature of 76 degrees with the outside temperature at 90 degrees, and that when the room was crowded with 1,400 persons. The size of the room is 80 x 80 x 20 feet high, and the amount of ice melted averaged about 13,000 pounds for each of the three nights of the exercises. The fans delivered 3,000,000 cubic feet of air per hour through the ducts and over the racks upon which the ice was laid. A plenum fan and an exhaust fan were used to create the circulation. The racks were built with five shelves consisting of slats through which the air

currents could freely circulate. The calcium chloride was disposed in shallow pans having perforated bottoms so that the accumulated moisture could drain off readily, and in this connection it should be mentioned that the calcium chloride must be chemically pure in order to be effective in removing the moisture from the air.

The movement is now well under way for a memorial to commemorate the first successful iron works in America. The memorial is to take the form of a monument to be erected in Taunton, Mass., where the first iron masters, James Leonard and Henry Leonard, started in business in 1653. The remarkable development of the iron industry in recent years and the interesting history of its establishment in this country have caused iron men to be deeply interested in the project. The initial steps in the matter were taken at a meeting of the Old Colony Historical Society, held in the city of Taunton. The descendants of the first successful iron masters who started in business in Taunton in 1653 were called together under the auspices of this society, and as a result of that meeting an executive committee was appointed for the purpose of securing funds and superintending the erection of a memorial to mark the introduction of this great industry in America.

The design for the monument is by Charles Henry Niehaus, the eminent sculptor. There is to be a shaft of granite 75 feet high, at the base of which are sculptured figures, representing the rugged pioneers of the iron industry. The shaft will be topped with an electric star as the symbol of the Light of Industry. There are to be legendary figures of heroic size placed at the four angles of the monument representing four of the Greek gods, among them being Vulcan. The design is pronounced by those who have seen it in the sculptor's studio to be in every way worthy of the subject which it commemorates.

### AIR-PUMP EXHAUST.

*American Electrician*, June, 1903.

In an article on steam plant auxiliaries Mr. Henry C. Meyer, Jr., expressed the opinion that it is poor practice to connect the air-pump exhaust to the condenser in order to give the steam cylinder of the air-pump the benefit of the vacuum, provided there is not sufficient exhaust steam from the other auxiliaries to heat the feedwater to about 200 degrees F. In such cases it is much more economical to use the air-pump exhaust for heating the feedwater than to turn it into the condenser. In the first case nearly all the heat is returned to the boiler with the feedwater, but if turned into the condenser most of it goes to waste with the air-pump discharge.

### RE THE METRIC SYSTEM.

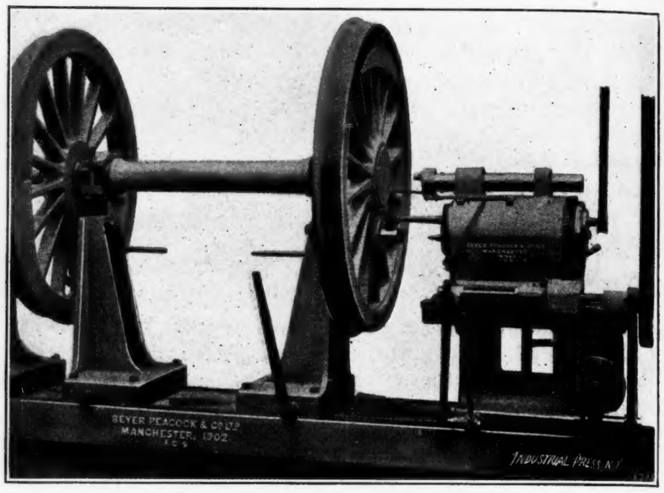
*Electrical World and Engineer*, June 13, 1903, p. 1,005.

In the days of old Rome, all numerical values, and therefore all quantities, such as sesterces, talents, sheep, or oxen, were written down in Roman numerals. The addition or multiplication of quantities thus symbolized was a task of relatively tremendous magnitude. Even the professional clerks, trained to the yoke, had to employ the abacus to help them. The labor wasted in the Roman system by the community aggregated a heavy tax. The Arabic system of numerals, which is now international, came to the Roman empire from the East. It offered enormous saving of labor, and rendered all weighings, measurements, records, and bookkeeping much easier. Every man could reckon for himself. But the Arabic system was only introduced after a long and protracted struggle against the fanaticism of the "sweating calculators" who opposed the innovation by every means in their power. In England at this date there appear to be very many intelligent men who oppose the introduction of a decimal currency such as ours, and advocate the retention of their ridiculously cumbersome and labor-creating system of pounds, guineas, shillings, florins, crowns, half-crowns, sixpences, threepenny bits, pence, half-pence, and farthings. The arguments they offer bear a gruesome likeness to those which are offered by the anti-metric system conservatives in this country.

### LOCOMOTIVE CRANKPIN GRINDING MACHINE.

*Engineering* (London), April 17, 1903. p. 507.

In article No. XIX. of the series "Grinding Machines and Processes," Mr. Joseph Horner describes a locomotive crankpin grinding machine of the sun-and-planet order, made by Beyer, Peacock & Co., Manchester, Eng. In this machine the drivers are mounted on columns or brackets provided with vees at the top into which the bearings are firmly clamped. Adjusting screws are provided in the brackets for varying the height of



Special Grinding Machine.

the drivers relatively to the grinder head at the right, and pilot centers on an outside bracket at the left and on the grinding head give means for exact adjustment. In this machine the emery wheel, of course, slowly revolves around the pin while it rapidly rotates on its own axis. Means are provided for varying the degree of eccentricity to suit pins of varying diameters, etc. The machine is said to do work of high precision and excellent finish.

### HIGH PRESSURE GAS DISTRIBUTION.

In a paper read by George F. Goodnow before the second annual meeting of the Wisconsin Gas Association, held in Kenosha, Wis., February 11-12, 1903, the author referred at length to the experience gained from the operation of a high-pressure gas distribution system in the town of Waukegan, Ill. The pressure carried is about twenty pounds per square inch, and regulators are employed at each lamp post and in each residence to reduce the pressure to that normally used. The reason for using high pressure is that much smaller distribution mains can be employed. Roughly speaking, a 1¼-inch pipe main will carry as much gas at a pressure of 20 pounds as a 4-inch pipe at the ordinary low pressures; and a 2-inch high-pressure main as much as a 6-inch low-pressure main. If the pressure was 30 pounds the capacity would be at least 50 per cent. greater. The leakage is not perceptibly greater than with low pressure. A gas compressor is, of course, used for getting the high pressure. The success of this example of high-pressure distribution of manufactured gas (natural gas has been distributed under high pressure from the beginning) may lead to important developments in the general scheme of gas manufacture and distribution in great cities. If it is practical to convey manufactured gas through mains under high pressure, why cannot the gas be manufactured at the coal mines and conveyed to the market by pipes instead of being hauled there in the shape of coal by railroad cars? It is not too much to expect that one of the developments of the twentieth century will be the elimination of the railway from the distribution of fuel to the eastern cities of the United States.

### REHEATERS AND SUPERHEATING.

*American Electrician*, June, 1903.

In an article on steam engines for electric power stations Mr. George I. Rockwood says that it has not yet been demonstrated that superheated steam effects any real saving of coal. None of the plants of which we have heard so much

within the past five years, especially designed to use highly superheated steam, has shown anything like the economy of coal of the Atlantic Mills plant, although they have shown phenomenal reductions in the weight of steam used per horse power per hour. The superheating not only eats up all it saves, but it increases friction and wear, and adds heavily to the first cost and running expenses of the plant. In the No. 4 mill of the Atlantic Mills referred to, at Providence, R. I., there is a small Corliss, compound, condensing, slow speed engine of about 500 horse power which gives one brake horse power on a coal consumption of 1.2 pounds per hour, and a steam consumption of 11.2 pounds per hour. That superheating does not effect a practical saving when the cost of doing the superheating is taken account of, is shown by the tests of the Cooper-Corliss engine at the Atlantic Mills, both with and without steam in its receiver. With steam in the jacket pipes the temperature of the receiver steam was raised 44 degrees above that normal to its pressure. No saving of heat whatever resulted, however, except the hot jacket drip that was returned to the boiler. The test proved, nevertheless, that a reheater increases the power of an engine without lowering its economy, the increase being about 12 per cent.

## HEATING AND VENTILATING THE MACHINE SHOP.

*Paper read by J. I. Lyle, of the Buffalo Forge Co., before the New York Railroad Club.*

The fans installed in hot blast heating systems differ very materially in their design. Two types of fans are used for heating; the disk or propeller type, and the centrifugal or steel plate type. The latter is used almost exclusively, as the disk fans, except for very small installations, have not been a success. With the centrifugal type of fan, the most economical results for heating are obtained when running the fan in coldest weather at a speed so the periphery of the wheel will travel at a velocity of approximately 4,500 to 5,200 feet per minute. In no part of the fan system design does practice differ so greatly as in construction and location of the hot air ducts. Several schemes are used, the most common being to construct the ducts of galvanized iron and to carry the horizontal runs overhead through the truss work, with warm air outlets spaced from 15 to 40 feet apart, these outlets being placed from 8 to 20 feet above the floor.

In the early installations the idea was to distribute very thoroughly, through ducts running practically all over the shop, a relatively small volume at a high temperature and to discharge it 6 feet or 8 feet above the floor and direct it so it would blow on the workmen. This practice resulted in much adverse criticism of the fan system, as the workmen in the line of the discharge were given colds and would be overheated, while those not in the direct path would not be heated sufficiently. The later practice for large shops has been to use large volumes of air at rather low temperatures and to use much shorter pipes and to allow the air to travel freely in the building for some distance. The outlets are usually from 10 feet to 20 feet above the floor. In this design advantage is taken of the fact that the warm air discharged high up travels toward the walls where it is cooled and becoming heavier falls to the floor; thus the walls assist the circulation. The direction of the winds largely determines the coldest side of the building and as the temperature of the wall will control to a certain extent the air currents, the coldest wall will cool the greatest amount of air, consequently the more air will be drawn in that direction. With the older installations of thorough distribution this was not accomplished so well and generally one side of the shop would be better heated than the other. Another advantage in placing the outlets high is that no air currents are felt by the occupants on the floor. Heating plants in machine shops are in successful operation now where the air is discharged 100 to 175 feet from the ends of the buildings, and in foundries it is blown as far as 250 feet.

Masonry or concrete ducts placed under the floor with stand-pipes located at intervals and extending above the floor, from 8 to 12 feet are in many cases used. In the Brown Hoisting Machinery Co., Cleveland, O., shops, the underground concrete duct is used and connected to the hollow steel columns supporting the building, which are used for the risers, discharging the air about 4 feet above the floor. In the Philadelphia & Reading shops, at Reading, Pa., no distributing pipes are used, but the hot air is discharged from the fan into the building overhead and the air returned to the apparatus by means of underground ducts with openings at the floor line and distributed through the shop.

The velocities of the hot air in the main ducts leading from the fans should never be greater than 2,500 feet per minute, and this velocity should be reduced gradually in the different branches so that the air is discharged from the outlets at from 800 to 1,200 feet per minute. Where the outlets are high, as in large buildings, 1,200 feet per minute can be used without any objectionable results; but where a thorough distribution is desired, and the outlets are placed within 6 or 8 feet from the floor, the velocity of air from the outlets should not be greater than 800 feet per minute.

In any shop installation, provision should be made for recirculating the air, and for the use of cold fresh air from the outside of the building. Occasionally it is found that a building can be heated easier by using part outside air and part return air than to use all return air. This is accounted for in the following way: Where the fan is blowing into and exhausting from the building, as in recirculating, the pressure maintained in the building is not greater than the outside, so the leakage of air around windows, doors, and crevices may be very great, while by the use of a part of fresh outside air a slight pressure can be maintained and to a large extent prevent this inward leakage. In either case cold air will of course be entering the building, but in the latter case the outside air will pass through the heater where it can be heated more economically and easier than by mixing it with the heated air in the building as it leaks in. In some cases it is found difficult to maintain uniform temperature throughout the buildings when using entirely return air, because it is difficult to keep the lower strata of air along the floor sufficiently warm, owing to leakage, though in the upper part of the building the temperature may be as high as 80 or 85 degrees. Because of the influence of local conditions, fan makers hesitate to give out data about their apparatus. The capacity of the steel plate centrifugal exhaust fan (inlet on one side only) when running under "free delivery" will be given approximately, however, by the formula:

$$C = 1.57\ D^2WR.$$

In which $C$ = capacity in cu. ft. per minute. $D$ = diameter of blast wheel in feet. $W$ = width of the blast wheel at the periphery in feet. $R$ = R. P. M.

By "free delivery" is meant to set the fan in the room and simply draw the air into the inlet and discharge into the same room without any piping, thereby avoiding ducts with the attending friction, other than the air passing through the fan.

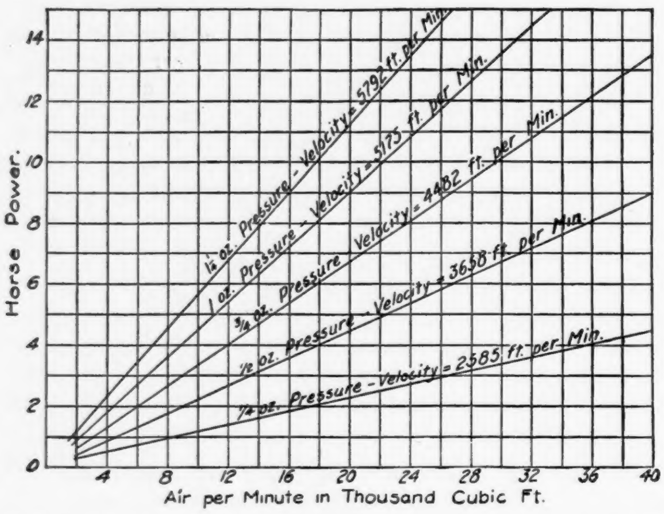
In factory buildings where short pipes of rather large diameter are used, thus reducing the friction, the formula $C = 1.25\ D^2WR$ will be found to be approximately correct. With long ducts terminating into many small outlets, the capacity will reduce from 10 per cent. to 20 per cent. as given by this last formula.

The delivery or capacity of a fan within the limits used in heating, varies directly as the speed of the fan. In a good installation with the fan running with a peripheral velocity of 5,200 feet per minute (approximately 1 ounce pressure with air at 62 degrees), from 2,200 to 2,500 cubic feet of air per minute will be delivered per horse power expended.

By proportioning the fan to meet the severest conditions of weather, say zero or colder, then in moderate weather of 20 degrees to 25 degrees above zero the fan will do the work easily at three-fourths the speed, the delivery varying with the speed; and the horse power will be reduced more than one half, giving 3,850 to 4,300 cubic feet of air delivered per minute per horse power. As the number of zero days during the winter are comparatively few, it will be found in the majority of cases that the cost of power to run the fans on such days at one ounce pressure is less than the interest on the increased cost of a larger fan designed to operate at a slower speed in the severest weather.

As to whether a steam engine or electric motor is the

better for driving the fan depends upon the local conditions. If there is not sufficient exhaust steam to do the heating, an engine-driven fan is the more economical as its exhaust can be used. Fully 75 per cent. of the heat of the steam supplied to the engine is available for heating, as the cylinder condensation and expansion will not amount to more than 25 per cent. An engine-driven fan also has the additional advantage of being independent of the electric plant; so the heating plant can be operated when the electric plant is shut down. Where electric current is constantly available together with sufficient exhaust steam, an electric motor is the most convenient and economical, as it is probable the electric generating units in such cases are large and consequently more economical than a small steam engine. If the fan apparatus is placed very far from the source of steam supply,




the condensation in high pressure steam pipes necessary for an engine is an item well worth saving. Where engines are used it is better to have them direct connected, but belted electric motors are preferable because of the large and expensive motor necessary for direct connection on account of the slow feed of the fan.

The curve shows the horse power required to move a given volume of air at different velocities or pressures.

## THE CONVERSION OF ALTERNATING INTO DIRECT CURRENT.

*Electrical Review*, May 23, 1903. p. 203.

A recent editorial in the *Electrical Review* describes the various methods of transforming alternating electric currents into direct currents. Briefly they are as follows: 1. The motor-generator in which an alternating current motor drives a direct-current generator, the two being coupled on the same shaft. 2. The rectifier which is a commutator driven by a synchronous motor. Since the synchronous motor keeps step with the alternating current generator from which it is supplied, the commutator also runs in step, so that by feeding the current by means of slip rings, the current impulses can be sorted out and supplied to the secondary circuit always in one direction, just the same as is done by the commutator of a direct-current dynamo. 3. The synchronous converter which is a synchronous motor fitted with a suitable commutator, may act as an alternating current motor and as a direct-current generator, and it can do both at the same time. The alternating current is first transformed down to the proper voltage and then supplied to the machine through slip rings to drive it as a synchronous motor. From the same winding by means of the commutator a direct current may be drawn. 4. Leblanc's converter is a peculiarly wound transformer connected to a stationary commutator upon which revolving brushes, driven by a small synchronous motor, press. 5. The electrolytic rectifier or electric valve depends on the property of certain metals in solution, allowing current from them to flow in one direction freely, but presenting considerable opposition to flow in the opposite direction. Attempting to pass an alternating current through a series of such combinations will cut out every other half wave and transmit a series of impulses all having the same direction. The opposite impulses may be sorted out in the same way and sent through the same circuit, thus giving a continuous direct current. 6. The Cooper-Hewitt mercury vapor converter is similar to the electric valve in that it allows the current to pass through it in one direction only. 7. The rectifying arc employs the repulsion of a magnet to an arc to separate the positive from the negative half waves. One electrode of an alternating current arc is split into two parts and insulated. The repulsion of a magnet brought near causes one set of waves to pass to one half of the electrode and the other set to the opposite half.

## THE AMERICAN WORKMAN FROM THE ENGLISH WORKMAN'S POINT OF VIEW.

*Page's Magazine* (London), June, 1903. p. 532.

The American workman as he appears to an English workman is graphically sketched in a short article in which the writer tells in his own way the story of his experiences in American shops, and records his impressions of American workmen. His preliminary word about employers is a good illustration of the true proverb that "Familiarity breeds contempt." "On first acquaintance," he says, "American shops and America generally, have a charm for almost everyone, and it depends on a man's temperament whether he falls permanently in with it or becomes hostile. I was struck favorably first with the genial and courteous manner of employers. Next I found they were always like it with strangers. Then I found they were practically on a level with the men, and expected to be spoken to in the same familiar way, and took it quite as a matter of course if their word was distrusted, or if they were abused or threatened."

The author's impression of the men themselves was at first favorable. "It was evident that in some ways they were on a higher level than the English workman, and except that they worked harder and longer, it was not apparent in what they could be worse off. Sixty hours a week, after the English fifty-four, seemed very hard, although I was getting nearly double English wages. It seemed remarkable, too, that, although the day was so long, and made worse still by dividing it into two long spells with only a more or less brief interval for dinner, that the work should be pursued diligently from the moment of starting until stopping time. The signs of hustle that I had expected were not noticeable, but even in the slowest shops there was practically no loafing. The general impulse seemed to be to turn out the work in the quickest and most straightforward way. Even with scarcely enough work in the shop, there seemed to be no holding back. Everyone made himself as comfortable as possible, but the work didn't stop. If it suited a man to sit down at what he was doing he sat down, and often spent more of the day seated than standing. If he was hungry he could spread quite an elaborate meal on the bench and eat as he worked. He is particular about temperature, and, in spite of the enormous variations outside, most shops are kept about the same all the year round—rather warmer than most Englishmen like, but the American reckons to work comfortably with coat and waistcoat off when the weather is at its coldest outside. Outside workers take more pains to protect themselves, and in very severe weather stop work altogether where possible."

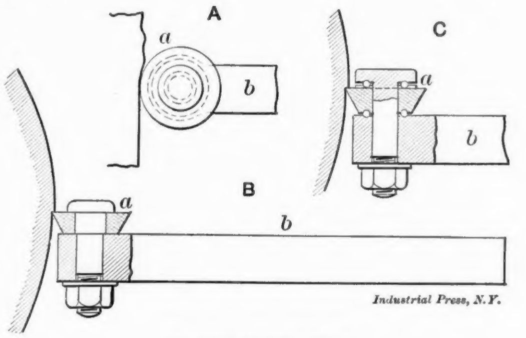
"The American workman's standard of living is unquestionably higher than the English, and would remain so, even if he went in as much as the Englishman for beer. He eats less in quantity, and less frequently, and does not enjoy eating much, but there is more variety in his food. It costs about the same in England, but, no doubt, considerably more is spent on it. He dresses better, and lives in a better house. Comparatively few men care to go through the streets from work with dirty faces and hands and clothes. In some cases they make an entire change night and morning in the shop, so that outside they are as well dressed as a business man. The time, however, during which they can appear like this is brief. As with work, so with relaxation. It cannot be taken in so leisurely a manner as here. Holidays have to be taken in a very sober fashion, for the custom is to have one day only at a time, and start promptly at the regular time next morning."

### CIRCULAR TOOL FOR TURNING HARD CAST ROLLS.

*Der Praktische Machinen Konstrukteur*, April 9, 1903, page 66.

Heinrich Stadler, of Turn, states that in the turning of the hard rolls of the machines it is a disagreeable experience that good hard turning steel will not stand up to the work. Consequently, much time is lost in the removal, grinding and replacement of the same. In order to remedy this trouble he has made an application of the circular cutter so extensively used in the paper industry.

The arrangement used for this purpose is clearly shown in sketch at *A* and *B*, where it is shown set in a movable tool holder *b*, which is, in turn, held by a toolpost. At the same time the little wheel *a* must be free to turn, while at work, upon its bolt. On the other hand, it is essential that it should stand still, except for the action of the side pressure due to the feed by which the rate of revolution of the wheel is regulated.




Circular Turning Tool.

As with other tools, the wear of the wheel after a short time must always be taken into account, so that it should be crowded into the work to a corresponding extent.

By the simultaneous use of two such wheels a remarkable increase of efficiency can be obtained. Furthermore the durability in service is from thirty to thirty-five times as great as with the standard form of turning tool. On the other hand, there is the disadvantage that heavy cuts cannot be taken.

According to the author, the revolution of the wheel can be greatly facilitated if it is carried on ball bearings, as shown at *C*.—G. L. F.

### THE MANUFACTURE OF SEAMLESS BOILER TUBES.

*Journal of the Society of Naval Engineers*, May, 1903.

In this article the author, Lieut. Newton Mansfield, refers to lack of endurance of boiler tubes in modern marine boilers carrying high pressures. Tests have been made on specimens of charcoal iron, cold-drawn mild steel, hot-drawn mild steel, and lap-welded steel boiler tubes immersed in distilled water through which air was percolated. These tests, made independently by officers of the United States Navy, showed that hot-drawn steel tubes free from millscale, showed the least corrosion, although the superiority over the cold-drawn and lap-welded steel tubes was not very marked. It was stated that nickel-steel having from 30 to 35 per cent. nickel is practically incorrodible, and has been used for some time in France for the boiler tubes of torpedo boats and destroyers. It is of prime importance that the interior of tubes be smooth and free from millscale, and as the use of this tubing is to be extensive in our navy in the future, the process of manufacture by which this and other desirable features are obtained, is given at considerable length, from which the following is taken:

The material is mild, open-hearth, basic steel taken from the bottom half of the ingots and received at the tube mill in round bars of from three to four inches in diameter and from eight to ten feet long, having an average tensile strength, 52,400 pounds per square inch; average elastic limit, 30,400 pounds per square inch, average elongation, 25 per cent. in eight inches, and average reduction of area, 56 per cent. The approximate chemical composition is: Carbon, .17 per cent.; manganese, .45 per cent.; sulphur, .025 per cent.; phosphorus, .01 per cent.

The manufacture of the tube is comparatively simple, yet of such a nature that none but the best product should finally reach the finished state. The process may be divided into two parts, viz:

1. The hot treatment.
2. The cold treatment.

#### The Hot Treatment.

The round bars of steel are heated to a cherry red in a closed gas furnace, and are sawed at this heat, by a circular saw, in length commensurate with the required length of the finished tube. These sawed lengths are not allowed to cool, but are immediately put into another closed gas furnace and heated to a light-yellow heat. This second heating is gradual, the time required being from twenty to forty minutes. The distillation of bituminous coal is used as the gas for heating. The "billets," as the sawed lengths are now called, are placed in the coldest part of the furnace and rolled from time to time in the hottest part, so that every part of the billet may have the same temperature. The billets upon reaching the required temperature are taken out and delivered to the piercing mill, the principle of which is shown in Fig. 1.

The piercing mill consists of two disks of cast steel carried on the ends of two shafts whose center lines lie in the same horizontal plane, but slightly inclined to each other. The shafts revolve in opposite directions and make one hundred and twenty revolutions per minute. The faces of the disks may be brought nearer to each other or separated by adjusting screws to accommodate billets of different diameters.

The billet in its yellow-heat temperature is laid on a small guide between the faces of the disks so as to bring the axis of the billet in the same horizontal plane in which the axes of the disks lie. The billet is then pushed by hand until its forward end takes against the revolving disks. The principle of the belt climbing to the high side of the pulley forces the billet on to the piercing point, which is shown in Fig. 1.

The piercing point pierces the billet while the beveled surfaces of the disks roll the pierced billet out smoothly as it advances over the piercing point. The piercing point and its mandrel are firmly supported so that the piercing point enters the center of the billet. This is not held rigidly in place, however, but is allowed to revolve with the billet. Its rear end is held in a swivel amply strong to take the thrust of the advancing billet. After each billet is pierced, the piercing

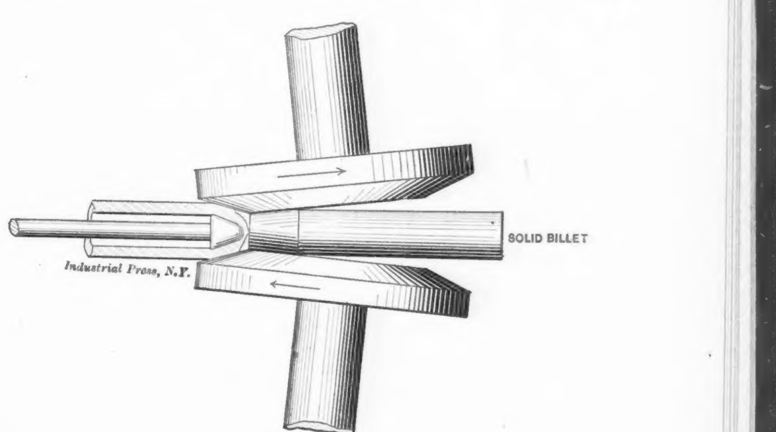



Fig. 1.

point and its mandrel are dipped in cold water to lower their temperature. (Both disks are constantly cooled by a stream of cold water.) The piercing point is made of the hardest steel. The piercing of a billet is a severe test of the homogeneousness of the material.

The range of temperature within which a billet must be pierced is very small. If the metal is too cold, the billet is sometimes torn or will stop the mill; or if too hot, the resulting tube may be very rough and contain injurious spiral twists. If the temperature is just right and the billet is in every respect a good one, it goes through the mill smoothly, coming out with a central longitudinal hole, fairly smooth on the inside and carrying considerable millscale on the outside surface.

The billet is now about twice its original length. It is not allowed to cool, but is passed immediately through the rolls.

The rolls are the ordinary cast-iron rolls used in steel mills, but as the tube is rolled it is made to slide over a mandrel, whose point is held between the rolls. Should the "tube," as it is now called, cool too much for rolling, it is placed in a convenient furnace to receive the proper heat, but this is not done except in very long tubes that cannot be rolled with the one heat of the piercing mill. The tube is given from four to eight passes through the rolls, care being taken that the tube is turned through about ninety degrees after each pass, in order that the walls may be rolled of even thickness. The tube is now about four or five times the length of the original billet and has a wall of about one-quarter inch in excess of the required thickness in the finished tube, while the excess in diameter over the finished tube is about one-half inch. There is little or no mill-scale on the inside, but considerable on the outside. This ends the hot treatment.

### The Cold Treatment.

The tube, coming from the rolls with a fairly smooth surface on the outside and a smoother surface on the inside, is allowed to cool to the temperature of the air. It is then pointed. This is done by heating one end of the tube for a length of about one foot and crushing from six to eight inches of this heated end in a pneumatic hammer, forming a point so that the end of the tube may be started through a die of smaller diameter than the tube. This die is shown in Fig. 2. This point serves as a gripping surface for the pliers which pull the tube through the die.

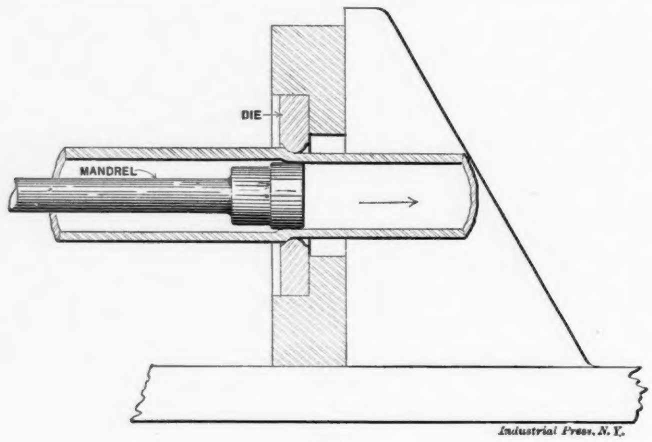



Fig. 2.

The tube, having been pointed, is taken to the pickling room and immersed in a hot, though weak, solution of sulphuric acid. This pickling removes the scale. After this immersion in the bath of hot sulphuric acid the tube is immersed in a bath of fresh water which washes away the loosened scale. The tube is then immersed in a mixture of tallow and paste, the paste being made of flour and hot water. This last operation, is called "dopeing." After "dopeing" the tube is dried for about five minutes in a hot oven. The tube is now ready for the cold-draw bench room.

### The Cold Drawing.

The principle of the draw bench is shown in Fig. 2. The tube at its pointed end is closed, but the other end is open. Into the open end the mandrel is shoved until the mandrel takes against the pointed end on the inside of the tube. The mandrel is carried on one end of a long rod, the other end of which is secured to the draw bench to hold the mandrel in its proper position relative to the die. The pointed end of the tube with the mandrel on the inside is now passed into the die and the drawing pliers are made to grip the point. They work on the principle of ice tongs. Toes on the pliers engage in an endless sprocket chain which, traveling at the rate of ten feet per minute, slowly draws the tube through the die. The tube having passed through the die is reduced in diameter, being reduced in thickness and lengthened about 20 per cent. Both inside and outside surfaces are smooth, almost polished.

The effect on the tube undergoing the process of cold drawing, is good evidence of the quality of the material. If the material be of meager ductility the tube will tear in two, and if the material be not homogeneous, it will show in the surface as spongy spots, checks or small transverse tears. It will be noticed that the mandrel in Fig. 2 has no side support other than the metal of the tube. By reason of this, hard spots easily displace it in drawing which shows up on the inside surface. The tube is always drawn beyond its elastic limit. After the tube has made one pass on the cold-draw bench it is annealed in an open furnace which uses the distillation of bituminous coal as a source of heat. The temperature of annealing is that of cherry red, but may be so regulated as to affect the ductility and tensile strength within certain well-known limits. The tube having reached the required temperature is taken from the oven and allowed to cool in the air, after which it is again pickled and immersed in the mixture of "dope," and dried. It is now ready for a second pass on the cold-draw bench.

The number of times a tube is drawn on the cold-draw bench depends on 1, the thickness of the wall of the finished tube; 2, the tensile strength of the material of the tube; 3, the tensile strength of the rod holding the mandrel in its relative position to the die.

It is seen that in the cold drawing the pliers tend to pull the tube apart at the die, causing a tensile stress at the die which must be resisted by the tensile strength of the material in the tube. The ability of tubes to resist this tensile stress is manifestly greater in tubes of thick than thin wall, considering the area of the cross section of the tubes as resisting surface. It must not be forgotten that, as the tube is drawn through the die, and the metal is "sunk" around the mandrel, the friction between the inside of the tube and the mandrel tends to pull the mandrel through the die. This is resisted by the tensile strength of the mandrel rod.

In reducing a tube from a larger to a smaller diameter and from a thicker to a thinner wall, it must be borne in mind that required reduction must not be obtained by a pull equal to the tensile strength of the tube; and, further, the friction between the inside of the tube and the mandrel must be less than the elastic limit of the mandrel rod. If these two conditions are fulfilled the tube may be drawn safely.

Large tubes of thick wall, therefore, do not require so many passes on the draw bench as tubes of smaller diameter and thinner wall. For instance, the 2-inch, 8 B.W.G. that are now being manufactured for the boilers of our ships receive but two passes on the cold-draw bench. In the first pass the diameter is reduced from 2½ inches to 2 3-16 inches, while the wall is reduced from 5-16 (.3125) inch to 7-32 (.21875) inch. The second pass further reduces the diameter from 2 3-16 inches to 2 inches and the wall from 7-32 (.21875) to 8 B.W.G., or .165 inch.

A tube of 1 inch diameter and 11 B.W.G., as is used in the boilers of our torpedo boats, requires at least five passes. The reductions of diameter are from 1½ to 1⅜, 1¼, 1 3-16, 1⅛, and 1 inch respectively, while the five passes reduce the thickness of the wall at the same time to the following dimensions, viz.: from ¼ (.25) to 7-32 (.21875), 3-16 (.1875), 11-64 (.171875), 5-32 (.15625), and 11 B.W.G. (.120) inch. Then follow inspection, hydraulic test under 1,000 pounds pressure, retort annealing and final inspection.

* * *

In his engineering reminiscences, now being published in *Power* and the *American Machinist*, Mr. Charles T. Porter refers to his experience in introducing the Richards steam engine indicator, which eventually supplanted the McNaught and Hopkinson indicators then in use (1863). It was earnestly desired that the new instrument should be so accurate and generally reliable as to command the respect of the engineering fraternity, as much depended upon the result of the venture. The problem of making the cylinders of the indicators so that each should have a diameter of .7979 inch, giving an area of .50 square inch, was solved by having a steel mandrel 20 inches long ground by the Whitworth Co. exactly parallel and to the internal diameter required for the cylinders. Brass tubes slightly larger in diameter which had been carefully cleaned, were drawn down on this mandrel. When pressed off they presented an internal surface, perfectly smooth and true to gage. The tube was then sawed up into lengths of about two inches for each cylinder.

## HIGH-SPEED LATHE WORK.

*Abstract from paper read by H. M. Norris before the Cincinnati Metal Trades Association.*

The gist of this paper is that a great range of cutting speed in an ordinary engine lathe which is to be used on a certain class of work, like shafting, that does not vary greatly in diameter, is not well adapted to getting the maximum efficiency from the best high-speed steels. In Cincinnati most of the machine tool builders are specialists and they put through their work in large lots. It is quite essential that each operation should be performed at the maximum speed the material will permit, as whatever percentage of time can be saved on one piece, can be saved on the entire lot. The question is asked: How can the greatest amount of metal be removed by a Novo tool in the most economical manner?

If a shaft is to be reduced ¼ inch, should it be done in one cut or in two cuts? Should we use a fine feed or a coarse feed? Should we operate at a periphery speed of 150 feet or at 300 feet? The tool will stand so much and no more. What is this "so much?" Is it reached at a speed of 10 feet less than that at which the tool is ruined, or at a speed of 20 feet less? It is probable that the lasting qualities of a tool depend upon the amount of heat that is generated at its cutting edge. If this is true, it is also probable that the life of the tool is shortened with every increase in either speed, feed or depth of cut. But which generates the more heat—a deep cut under a fine feed or a shallow cut under a coarse feed? If we can settle this point the question will resolve itself down to a matter of periphery speed. Of course the tools will vary, so will also the material upon which they operate; but by making all the tests upon shafts cut from the same bar, and repeating each three times with different tools, we should be able to obtain a line on at least one of the laws that govern high speed cutting. This, then, is obviously our starting point, and inasmuch as the average run of our work will not permit our taking a cut in which the cross section of the chip is greater than ⅛ x 3-64 inch our test had best be confined to cuts of 1-16, 3-32 and ⅛ inch in depth by 1-64, 1-32 and 6-64 inch in thickness. The question, therefore, is to find the maximum speed at which the tool will operate under each of these cuts. How can this be determined? If we had a sufficiently powerful variable speed countershaft the speed could be increased as the cut advanced; but how would we know at what speed we were running at the moment the tool gave way? We know that on some work a Novo tool will stand a speed of 180 feet; so we might run a minute at 190, another minute at 200, and another at 210, etc., but the cuts would hardly be of sufficient duration to prove much. Then, too, having 27 tools to ruin, it would consume too much time. But what is the objection to operating on a conical shaft? The tools will probably be destroyed at a speed between 200 and 400 feet. This means that the large end of the shaft would have to be twice the

TABLE I. CUTTING SPEEDS.

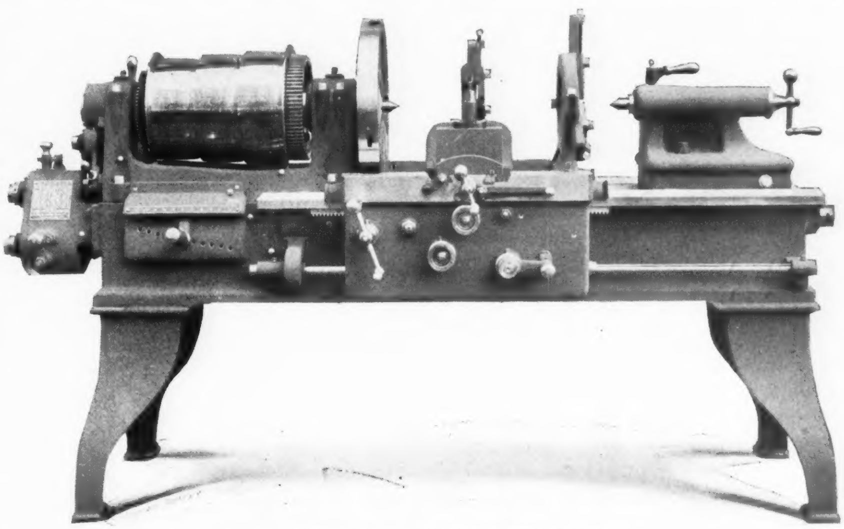
| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Feeds. | $\frac{1}{64}$ | $\frac{1}{32}$ | $\frac{3}{64}$ | Average |
| Cut. $\frac{1}{16}$ | 326 | 320 | 381 | 342.3 |
| " | 425 | 360 | 327 | 370.6 |
| " | 339 | 354 | 330 | 341. |
| 1 Average | 363.3 | 344.6 | 346 | 351.3 |
| $\frac{3}{32}$ | 326 | 230 | 262 | 272.6 |
| " | 368 | 268 | 209 | 281.6 |
| " | 332 | 285 | 227 | 281.3 |
| 2 Average | 342 | 261 | 232.6 | 278 5 |
| ⅛ | 336 | 259 | 231 | 275.3 |
| " | 326 | 260 | 220 | 268.6 |
| " | 310 | 267 | 240 | 272.3 |
| 3 Average | 324 | 262 | 230.3 | 272.1 |

TABLE II. CUBIC INCHES OF STOCK REMOVED.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Feeds. | $\frac{1}{64}$ | $\frac{1}{32}$ | $\frac{3}{64}$ | Average |
| Cut. $\frac{1}{16}$ | 3.822 | 7.502 | 13 40 | 8 241 |
| " | 4.982 | 8.440 | 11.50 | 8.307 |
| " | 3.974 | 8.299 | 11.60 | 7.957 |
| 1 Average | 4.259 | 8.080 | 12.166 | 8.168 |
| $\frac{3}{32}$ | 5.732 | 8.089 | 13.821 | 9 214 |
| " | 6.471 | 9.425 | 11.025 | 8.973 |
| " | 5.838 | 10.023 | 11.975 | 9.278 |
| 2 Average | 6.013 | 9.179 | 12.273 | 9.155 |
| ⅛ | 7.8785 | 12.144 | 16.274 | 12.089 |
| " | 7.643 | 12.192 | 15 474 | 11.769 |
| " | 7.268 | 12 52 | 16.88 | 12.222 |
| 3 Average | 7.597 | 12.285 | 16.203 | 12.0069 |

diameter of the small end. If the length is kept within 24 inches we can use a taper attachment.

Six taper shafts were made from the same bar of steel and tested in the manner outlined. Table 1 gives the cutting speed at the moment the point was destroyed, and Table 2 gives the cubic inches of steel being removed at the same time. Tests made under water showed an average of less than 10 per cent. increase of speed, which is regarded as a distinct advantage, considering the trouble we would be put to if it could be demonstrated that water greatly increased the efficiency of the tool. Some of the conclusions reached by the tests are summarized as follows:



American Tool Works Co.'s High-Speed Lathe.

1. That a tailstock center made of Novo steel is much longer lived than the centers furnished by the manufacturers.
2. That after a tool has been burned its end should be cut off at least a 16th inside the burnt portion.
3. That white chips do not indicate that a tool is operating at less than its maximum speed.
4. That each successive cut on a shaft permits of a higher cutting speed than the previous one.
5. That while water may be beneficial as a check on the expansion of work its other advantages are too slight to warrant our using it in general practice.
6. That until such time as means are devised for compensating for the expansion of the work it is inexpedient to operate on the average grade of steel at a speed greater than 175 feet per minute.

Next in order for consideration is the question of how to avail ourselves of the high efficiency of these tools. None of our shafting is larger than 4 inches, and little of it smaller than 1 inch, so if a cutting speed of 175 feet per minute is the maximum speed at which we should attempt to operate, it will be unnecessary for the lathe spindle to run faster than 668 revolutions per minute or slower than 167 revolutions per minute.

It is possible to so grade the speeds between these limits that by employing 12 speed changes none will be so much as

10 per cent. lower than the desired speed of 175 feet per minute. These speeds are obtained by means of a three-step cone, with diameters varying only by small amounts and a back-gear ratio of 2.13 to 1, and a two-speed friction countershaft.

Comparing such a lathe with one of ordinary pattern, having five steps ranging from 4 to 12 inches, and back gear ratio of 12.35 to 1, we find that the latter is entirely unsuitable for high-speed cutting.

It has been shown that the maximum speed need be but four times faster than the minimum speed, while on this machine the maximum speed is more than 111 times the minimum speed. If, therefore, the lathe is speeded so that its maximum speed will cut a 1-inch shaft at the rate of 175 feet per minute, it will obviously require a diameter of 111 inches to maintain the same cutting speed when running at the minimum speed—which is rather a large piece to swing in an 18-inch lathe. And what is true of the slowest speed is true of six of the others. There are but three speeds adapted to work between 1 and 4 inches in diameter; a 3⅛-inch shaft has to be turned at the same speed as a 4-inch, a 1⅞ at the same speed as a 3, and a 1⅛ at the same speed as a 1¾. Now let us see what this means to us in the course of a year if both lathes were kept employed on 1⅛-inch work. Allowing 55 hours to the work and 50 weeks to the year makes a run of 2,750 hours. Taking wages at 20 cents per hour, and general expense at 25 cents per hour, makes the output of each lathe cost .45 × 2,750, or $1,237.50. Assuming the selling price of this work at 1¼ times what it cost to produce on an ordinary lathe, gives us a return of 1¼ × 1,237.5, or $1,546.88, which we will call the market price of 109 finished shafts. This brings us to the following proposition. If a lathe operating at a cutting speed of 109 feet per minute turns out 109 shafts per year, how many shafts a year can be turned out on a lathe operating at a cutting speed of 174 feet per minute? If we disregard the time consumed in handling the work, the answer is 174 shafts, or 59.6 per cent. more than can be turned out at the lower speed, in which event we would receive for the year's output 1.6 × 1,546.88, or $2,475. The cost, however, remains as before, but instead of profits being but $1,546.88—$1,237.50, $309.38, they are $2,475 — $1,237.50, $1,237.50, or or more than four times as large.

This, however, is an extreme case, as the average cutting speed on our special lathe is but 22 per cent. more efficient than the average cutting speed on the standard lathe, so at such times as the lathes are employed on a variety of diameters it is not likely that the profits on the product of the special lathe would be more than twice those earned on the product of the standard machine. But all of this is based on the assumption that the standard lathe has sufficient power to remove a chip of the same sectional area as the special lathe. We were told at the last meeting that the belt on a 36-inch lathe driven by a 45-inch pulley slipped under a cut of 1-16 x 1-32 inch, which would indicate that the ordinary 18-inch lathe will not begin to stand the cuts we can take on our special lathe. Why is this? How do we obtain so much more power? If we ask the builder if a certain lathe is powerful enough to perform certain work, he will answer: "Yes, it is geared in the ratio of 12 to 1," or he will say: "It's the highest geared machine on the market, which gives it power to burn." What, then, can we expect from a lathe geared in the ratio of 2 to 1? Let us see.

The maximum speed of both lathes is the same; each runs at 668 revolutions per minute. A 4-inch pulley running at this speed gives a belt travel of 699.53 feet per minute, which, multiplied by the width of the belt, gives a surface speed of 145.71 square feet per minute, as against a surface speed of 672.23 obtained from a 4-inch belt running on an 11 17-32-inch pulley. The surface speed of the one is to the surface speed of the other as 4.61 is to 1, so if both lathes are driven by belts of equal thickness the available power of the special lathe will be 4.61 times that of the ordinary lathe. It is a well-known fact, however, that a heavy double belt will not operate to advantage on a 4-inch pulley. It is also a fact that a double belt will transmit ten-sevenths the power of a single belt, which increases the power of a special lathe to 6.59 times that of the ordinary lathe. Then, too, there is the gain due to the additional arc of contact. In the ordinary lathe this arc is approximately 133 degrees, while in the special the arc is approximately 179 degrees, which increases our power to 8.87 times that of the ordinary lathe. "But how about the ratio of the back gears?" asks the lathe builder. The back gears? What have they to do with it? Is there any combination of gears in the world that will enable a machine to perform more work than the belt supplies power for? Here, then, is where the lathe builder falls down. He knows that the greater the ratio the greater the cut, but entirely overlooks the fact that where power is obtained at a forfeiture of speed the greater the ratio the greater the curtailment of profits.

[The lathe used by Mr. Norris in making these tests was the new "American" high-speed lathe, manufactured by the American Tool Works Company, Cincinnati. The lathe is particularly adapted for work from one to four inches in diameter and differs from the ordinary lathe in that it is designed throughout to meet the special requirements of modern high-speed tool steels. The limit of work is placed at the tool rather than at the belt, and with this in view, the apron, carriage, and bed, and so on have been given exceptional strength, and the headstock enormous belt power—such that the contact of belt when on the smallest step of the cone is greater than in the ordinary 36-inch lathe. The cone is so designed that a four-inch double belt can be shifted to any of the three steps with the greatest facility. There are twelve changes of speed so graded that a cutting speed of 160 feet per minute or thereabouts can be maintained on work ranging from 1 inch to 4 inches diameter. The bearings, owing to the high spindle speeds, are of unusual size, made of phosphor bronze, and are self-oiling. The makers are prepared to build headstocks similar to the above, but specially adapted to individual requirements. The leadscrew is placed on the inside of the bed and the feed box will give 44 changes for feeds or for screw cutting, without having to remove a single gear.—Editor.]

* * *

## ITEMS OF MECHANICAL INTEREST.

### A FILE FOR BRASS–STRENGTHENING A CHIMNEY–MILLING HEXAGON BOLT HEADS–FLEXIBLE CABLE HANGER – VALVE-MOTION MODEL.

A watch fitted with a balance wheel made of the nickel-steel alloy known as "invar," has been tested at the Kew observatory and given a certificate denoting wonderful time-keeping qualities. The mean variation of daily rates for one degree Fahrenheit, was only 0.004 second. "Invar" may be obtained from J. H. Agar Baugh, 92 Hatton Garden, London, E. C. Recent tests made at the National Physical Laboratory at Teddington and the International Weights and Measures Office at Sevres on "invar" bars of two grades, between the limits of 41 and 86 degrees F., showed a variable coefficient, the limits being 0.00000063 and 0.00000088 with a mean of about 0.00000073 per degree F.

That the opportunities for labor-saving are present in almost every business, is undoubtedly true, but it often takes a genius to discover them. How many persons have been observant enough to note the trouble and time required for the letter carrier to unload a letter box filled with mail matter? That some inventor has been, is evidenced by letter boxes that may be seen in the streets of at least one New England city. They are made with a hinged bottom and provision is made for hooking the mouth of the mail sack over the bottom so that when the lid is released the contents of the box drop into the pouch in the "twinkling of an eye."

At the Chemical Congress held in Berlin during the first days of June, great interest was manifested in the wonderful properties of polonium, the new element discovered by Prof. and Mme. Curie of Paris and publicly displayed at the Congress for the first time. The amount shown was only 15-100 grain, but it required two tons of uranium to produce it, and cost about $75, or at the rate of $2,880,000 a pound. Polonium is said to intercept electric sparks when placed between the electrodes. Pieces of barium, platinum and zincblende placed

near polonium in a darkened room, glow with a bright, greenish light, giving visual evidence of peculiar radiations of great power.

### A FILE FOR BRASS.

The *Mechanical Review* describes in one of its recent issues a new type of file, specially devised for working upon gun metal that has been introduced into the engineering department of the Chemin de Fer du Nord, France. The feature of this tool which distinguishes it from the general type of file is a series of shallow channels which cross its face diagonally at an angle of 30 deg., and placed about half an inch apart. The raised portions of the surface of the file between these channels are occupied by the teeth of the tool. The advantages of the file are that it clogs less rapidly, and can easily and quickly be re-sharpened on the sand-blast, while it increases the work of the engineer who uses it in connection with gun metal filing, by 30 per cent.

### STRENGTHENING A CHIMNEY.

Some time ago at a certain railroad shop, the chimney showed signs of weakening when it became necessary to enter it with a new and enlarged breeching adapted for an increase that had been made in the boilers and engines. In order to prevent a collapse, the lower portion of the chimney was

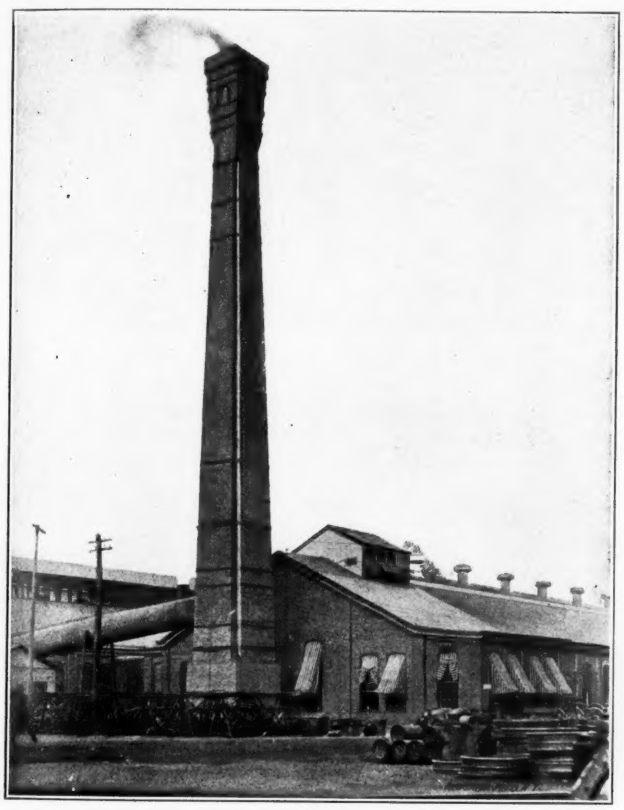


Fig. 1. Chimney Strengthened with Bands.

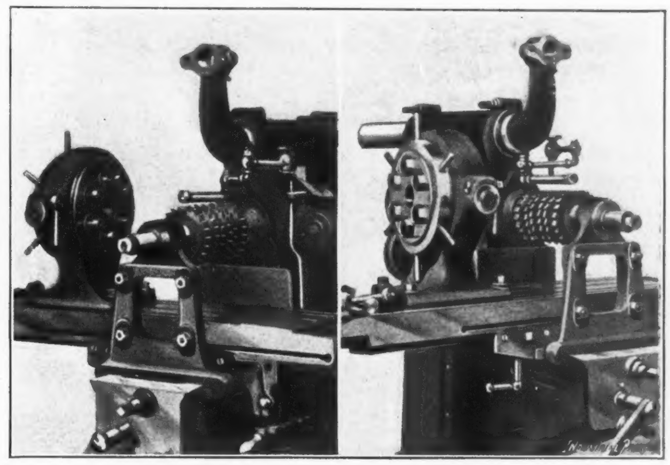
banded in six places with heavy bands tightened by bolts in the same way as tank bands are set up. Three were also put near the top and in this way the structure has been so strengthened that it is apparently as stable and solid as a new chimney.

### FORMULA FOR COLORING BRASS.

To produce a black color on brass Edwin S. Sperry gives a formula in *Metal Industry* as follows: Dissolve one pound of plastic carbonate of copper in two gallons of strong ammonia; first boil the brass that is to be blackened, in a strong potash solution to remove all grease and oil; rinse well and dip in the copper and ammonia solution, which should be heated to 150 to 175 degrees F., until the desired degree of blackness is acquired. The color produced is very uniform and has little tendency to peel off. The process works best on brass containing much copper, or on what is known as "red" brass. Directions are also given for making the plastic carbonate of copper as follows: Blue vitriol (sulphate of copper) is dissolved in hot water and a strong solution of common washing soda is added to it so long as any precipitate forms. The precipitate is allowed to settle and the clear liquid is poured off. Hot water is now added and the mass stirred and again allowed to settle. Again the clear water is poured off and the operation of adding hot water, settling and pouring off is repeated until everything has been washed out of the green carbonate of copper which remains at the bottom of the vessel. This is the plastic carbonate of copper referred to.

### ENGLISH METHOD OF MILLING HEXAGON BOLT HEADS.

The *Engineer* (London) says that the method illustrated in Figs. 2 and 3 is one that is employed in the works of Alfred Herbert, Coventry, for milling the sides of hexagon nuts and bolt heads. Six cutters are mounted on the milling machine spindle so as to straddle three bolt heads at one time.



Figs. 2. and 3. Multiple Bolt Head Milling.

The bolts are held in a special fixture carrying six chucks mounted in a revolving frame or turret. Since two sides of three bolts are milled off at once, it is obvious that in effect one bolt head is milled complete at one operation, and indexing the turret one complete turn finishes six bolts or nuts. The bolts are inserted in the upper chucks, and, of course, the finished work is removed when it comes around to the same position. The cutters used on ⅝ inch bolts are 6 inches diameter and run at 46 turns per minute with a feed of ½ inch per minute. The output of ⅝ inch bolts, is about 35 per hour.

### SIMPLE CABLE HANGER.

The different steps indicated in Fig. 4, show the method of applying an exceedingly simple device for supporting electric cables from steel suspension wires as is necessary where

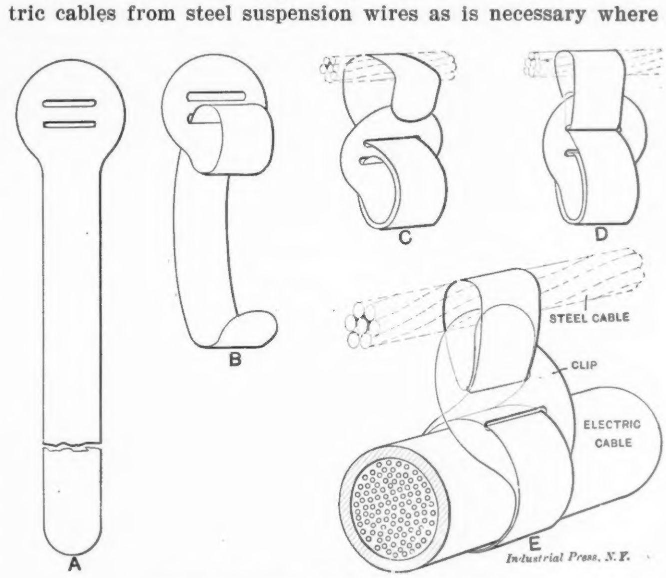



Fig. 4. New Hanger for Suspending Cable.

cables have to be carried in a long span between supports. The hanger is shown in *A*, and is a strip of zinc perforated at the bulbed end with two slots. *B* shows the first wrap around the cable; *C* the second wrap around the cable and

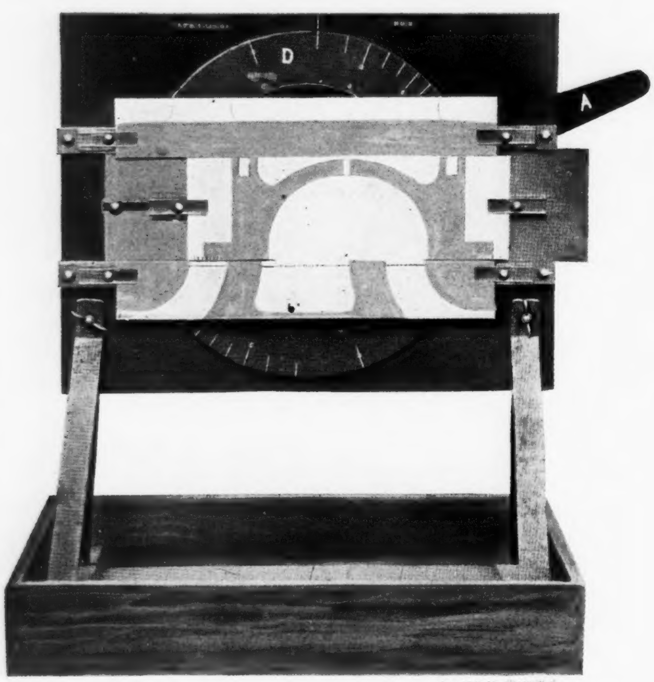
wrapping around the suspension wire; $D$ the end tucked through the upper slot and turned up; and $E$ the completed and assembled job. It is apparent that the weight on the tucked-in loop has a tendency to lock it tightly and prevent slipping. The device as a whole appears to be a very ingenious, simple and effective means of securing a desired result.

### COLVIN'S VALVE MOTION MODEL.

Steam engine valve-gear, its functions and the successive events of a cycle altogether make a subject for absorbing study in which the designer, practical engineer and all others interested in the mechanics of the steam engine, may delve with profit. It is a study, however, that is pursued with difficulty save by the aid of a working model on which the many combinations of lap, lead, angular advance, point of cut-off, etc., one with the others and with the piston travel, can be easily effected and observed. The trouble with the conventional valve-motion model is that it is bulky, inconvenient to operate and costly if made to a scale that is of any practical use. A locomotive valve-motion model made half-size requires a floor space of, say 3 feet by 7 feet, and a helper is a quite necessary adjunct to turn the crank. As a brake is never supplied by which the unhappy seeker for knowledge can stop the too-willing crank twister short, the apparatus is usually more productive of profanity than anything else. For home study such an ungainly rig is out of the question, and even in the lodge room the space required is often a serious objection.

The accompanying illustrations show a valve-motion model patented by Henry F. Colvin, which is of very compact design. It reproduces the various events of steam engine slide valves of different constructions, especially of locomotives, to full scale save one, the Vauclain piston valve, which is shown one half size. It is made to fold up and go into a box 14 x 18 x 3 inches. The box forms the base when the machine is set up, and then the total height is 21 inches. The valves, the sections representing the ports and the balance plate, are printed on strips of heavy cardboard, which are held in place by buttons as shown in Fig. 5. This view shows a Richardson balanced valve for 5 inches travel. Three D-valves for 5, 6 and 7 inches travel; an Allen ported valve; two piston valves, one for outside and the other for inside admission; a Vauclain piston valve; a Wilson high-pressure multi-ported valve (eight in all); and the accompanying port sections for each valve, are furnished with the outfit. All the parts are assembled by thumbscrews so that no wrenches or other tools are required.

Fig. 6 shows the back of the model and gives a more adequate idea of the principle on which it operates. The handle $A$ revolves a disk $D$, which is graduated on the face side to represent inches of piston travel, 24 inches stroke being taken as the base. When the zero mark corresponds to the datum line in Fig. 5, the crank is supposed to be on the center. Rectilinear motion is imparted to the valve by a peculiar combination of two connecting-rods, one of which shows at $C$. The other shows in Fig. 6 just above it through the slots in the plate $B$. This one is just one-half the length of $C$, center to center of the outer pin holes. One end is connected to the valve and the other to the center of $C$. Rod $C$ is connected to the plate $B$ at $E$, and the other end reciprocates in a short horizontal slot in the frame. Plate $B$ turns with the disk $D$ and, of course, the connecting-rod $C$ being pivoted to it at $E$, a crank motion is imparted to it, which in turn is transmitted to the valve through the short link alluded to. The point of connection $E$ can be changed along the curved slot, thus imitating the effect of the Stephenson link by increasing the lead as the link is hooked up for short cut-off. Or if located in the other curved slot, the effect of crossed eccentric rods is imitated, the lead decreasing as the cut-off is shortened. Constant lead at the various cut-offs can be effected by changing the thumb screw connection to the straight slot. Nominal lead is changed by loosening the thumb screws $F$ $F$ and shifting the slotted plate $B$ relative to the disk $D$. This has the same effect as changing the angular advance, and is virtually the same thing. Further information may be obtained from the Derry-Collard Co., 256 Broadway, New York.



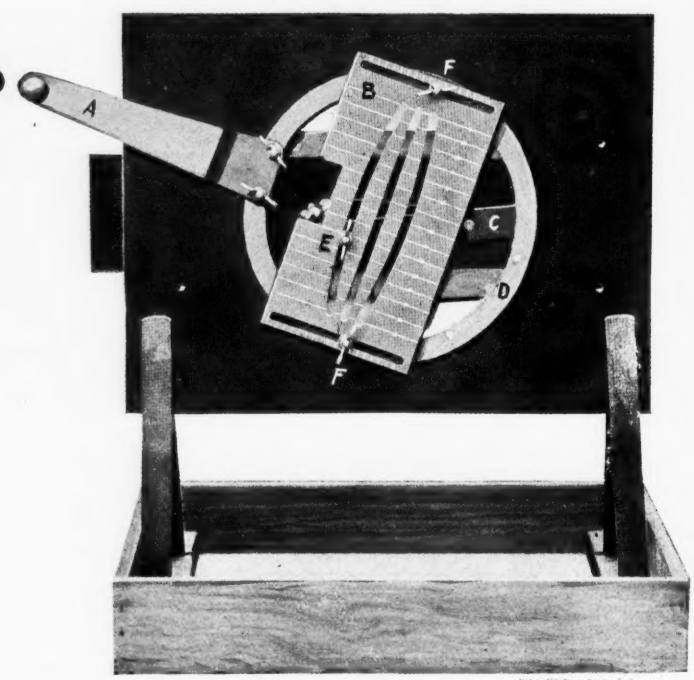




Fig. 5. Front View. Colvin's Valve Motion Model. Fig. 6. Back View.

* * *

An electric switch is being tried in Pittsburg by which the motorman can control the direction his car will take at a junction, without stopping the car or removing his hands from the controlling levers. A section of the trolley wire approaching the switch, is separated from the main line and is independently charged. It is so connected that if the car takes current when passing over this section a powerful electro-magnet in the track will be energized and throw the switch point. If the car approaching the junction is to continue without throwing the switch point, the motorman must shut off the current before reaching the switch operating section and pass over it by the momentum of the car. The switch then remains unchanged.

* * *

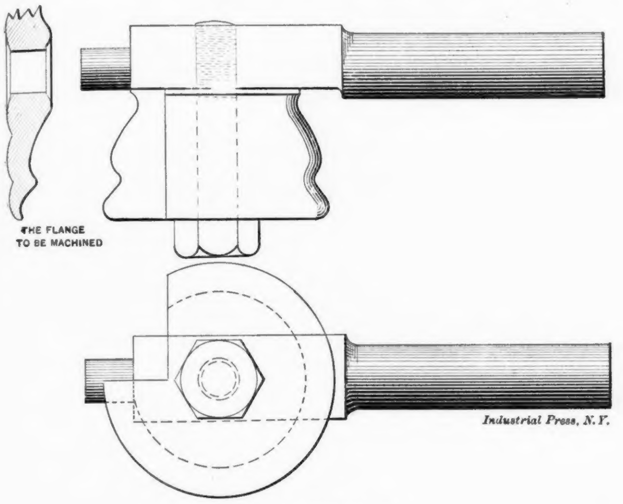
Descriptions of several interesting tools of original design have been contributed to our columns by Mr. Jos. M. Stabel. Mr. Stabel writes us that he has received several inquiries as to prices of these tools, etc., and wished to state that none of them are on sale and the ideas are simply contributed for the benefit of the readers of MACHINERY.

# LETTERS UPON PRACTICAL SUBJECTS.

## A FORMING TOOL FOR FINISHING FLANGES.

*Editor* MACHINERY:

For finishing the flanges of bath cocks it had always been customary for us to use four cutters in a holder and any toolmaker will appreciate the difficulty that we had to keep these cutters all of the same shape when they were ground. To obviate this trouble I designed the tool shown in the sketch, so that but a single cutter would be required. A round forming tool was made to correspond with the shape of the flange and this was fastened to a holder or shank, made from a piece of $1\frac{1}{2}$-inch square steel. One end of this shank was turned down to fit the hole in the turret while the front end




Flange Forming Tool.

was turned to fit the hole in the flange and acted as a guide and support for the cutter. The cutter was clamped to the holder by a bolt with a left-hand thread, so that the tendency of the tool, when at work, was to tighten itself against the shank. With this tool we are able to do much more and better work than we could with the old holder having four cutters and the grinding is, of course, reduced to one-quarter of the amount. There are many jobs of turret work where a cutter and holder of this description can be used to a great advantage. M. SCHILLING.

St. Paul, Minn.

## TESTING A LEADSCREW.

*Editor* MACHINERY:

In the May issue of MACHINERY, Mr. Stabel, in his article on micrometer measuring instruments, gives a method of testing the leadscrew of a lathe. He does this by chucking a micrometer screw so as to expose the threaded end and using an indicator held in the toolpost of the lathe, the point of the indicator bearing against the side of the thread, as shown in Fig. 5 of the sketches illustrating his article. I consider this method as being rather poor; first, because the leadscrew

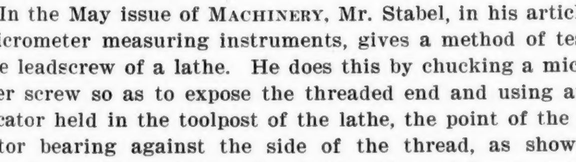



Fig. 1. Micrometer for Testing Leadscrew.

can be tested over a length of only about one inch, at a part determined by the location of the indicator with reference to the carriage; and secondly, because there are several chances for errors to creep in. To give satisfactory results the micrometer screw must not only be of the correct pitch but it must run perfectly true and be of uniform diameter. Otherwise the indicator will increase any existing error to such an extent that the results will be quite unreliable.

What I consider a much better way for testing the pitch of a leadscrew, at any position of its length, is to procure a micrometer screw and barrel complete, such as can be purchased from any of the manufacturers of accurate measuring instruments, and bore out a holder so that the axis of the micrometer screw will be parallel to its body when the screw is in place, as shown in Fig. 1. With the lathe geared for any selected pitch, the nut engaged with the leadscrew, and all backlash of screw, gears, etc., properly taken up, clamp the micrometer holder to the lathe bed, as shown in Fig. 2, so that the body of the holder is parallel to the carriage. Adjust the micrometer to one inch when the point of the screw bears against the carriage and with a surface gage scribe a line on the outer edge of the faceplate. Now rotate the lathe spindle any number of full revolutions that are required to cause the carriage to travel over the portion of the leadscrew that is being tested, bringing the line on the faceplate to the surface gage point. If the distance traveled by the carriage is not greater than one inch, the micrometer will indicate the error directly. For lengths of carriage travel

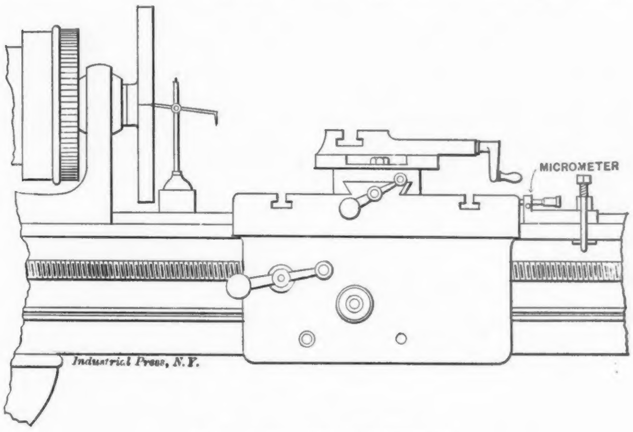



Fig. 2. Testing the Leadscrew.

greater than one inch an end measuring rod, set to the number of even inches required, can be used between the micrometer point and the lathe carriage. The error in the leadscrew is then easily determined by the adjustment that may be required to make a contact for the measuring points between the carriage and the micrometer screw. The pitch can be tested at as many points as are considered necessary by using end measuring rods, of lengths selected, set to good vernier calipers. The style of holder shown can, with the micrometer screw, be used for numerous other shop tests and as the screw is only held by friction caused by the clamping screw, it can easily be removed and placed in any form of holder that is found necessary. CANTELO.

## CORRECTION TO "PROPORTIONS OF GEARS."

*Editor* MACHINERY:

Referring to the article in your May number on "Proportions of Gears" by C. F. Blake, I desire to call attention to an error in his formulæ. In both the elliptical and T sections he substitutes,

$$R = \frac{n\,p}{2\,\pi} = .16\,n\,p$$

in which "$n$" is obviously the number of teeth, whereas he takes "$n$" to be the number of arms and uses this notation in his first formula,

$$M = \frac{W\,R}{n}$$

He should have substituted

$$R = .16\,N p$$

where "$N$" is the number of teeth. This reduces the final equations to the following:

$$\text{Elliptical section } h = \sqrt{2.7\,\frac{f\,y\,p\,N}{n}}$$

$$\text{T-section } h = \sqrt{1.6\,\frac{f\,y\,p\,N}{n}}$$

In the T section formula the constant 1.6 is correct, the decimal point having been wrongly placed in the original print, so as to read .016.

Mr. Blake's original formula gives the same value of "$h$" for all diameters of wheel and for all numbers of arms, which is obviously incorrect.

Using oval arms the somewhat general practice in the Pittsburg District is to make the thickness of arm $b = \frac{1}{2} h$, instead of making it depend directly on the pitch, as this gives a thicker arm and more lateral strength, the casting having been found to be readily made and not unduly strained.

Taking the same notation as Mr. Blake, which is as follows:

$h$ = width of arm at center of wheel.
$p$ = circular pitch.
$f$ = face.
$R$ = radius of gear.
$y$ = constant as per table, usually about 1-10.
$n$ = number of arms.
$b$ = thickness of arm at center of wheel.

We may write:

$$h = \sqrt[3]{\frac{20\,p\,f\,y\,R}{n}}$$

and $b = \frac{1}{2} h$, which give very good results over a wide range.

There is a "Rule of Thumb" which makes the width of arm just under the rim equal to $2 \times p$ tapering ¾-inch per foot, the thickness being $1 \times p$ tapering ⅜-inch per foot, which on careful consideration proves to be pretty well founded and to agree with the theoretical values fairly well.

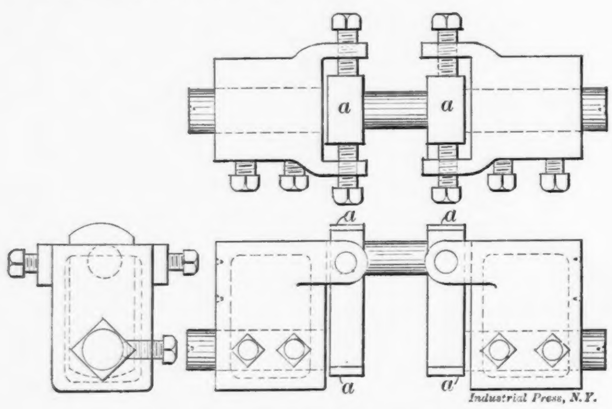



**Fig. 1. Dogs for Holding Crank Shafts.**

If we assume that in ordinary practice the following values are seldom exceeded:

$f = 4\,p$.
$y$ = constant, say 1-10.
$n = 6$.
$R = 20\,p$, equivalent to gear of 126 teeth.

We can write,

$$h = \sqrt[3]{\frac{20\,p \times 4\,p \times 20\,p}{10 \times 6}}$$

$$h = \sqrt[3]{26.6\,p^3} \text{ or nearly } h = 3\,p$$

Now, our "Rule of Thumb" will evidently come pretty close to this as the taper will in some measure allow for the large diameters and to show how near it will come, I have prepared the following approximate table in which $p = 2''$, $y$ = 1-10, and $n = 6$.

| | | $h = \sqrt{\frac{20\,p\,f\,y\,R}{n}}$ | | h by Rule of Thumb |
|---|---|---|---|---|
| No. of Teeth. | Radius. | $f = 6''$ | $f = 8''$ | $h = 2p + \frac{R}{16}$ |
| 30 | 9.5 | 3.5 | 3.7 | 4.5 |
| 50 | 15.9 | 4.0 | 4.4 | 4.9 |
| 70 | 22.3 | 4.5 | 5.1 | 5.4 |
| 90 | 28.6 | 4.9 | 5.4 | 5.8 |
| 110 | 35.0 | 5.2 | 5.7 | 6.2 |

From this table it is evident that the simple rule is practically correct and its simplicity recommends it in place of more elaborate formulas even though it will come somewhat heavy when narrow faces are used. In the smaller diameters the number of arms will usually be less than 6, which will make the agreement still better.

The above data was developed some years ago when the writer was looking into the matter of gear proportion, and is written in the hope that it may prove of some value to any of the readers of MACHINERY who may be engaged in work calling for the designs of well proportioned gears.

F. C. BIGGERT, JR.

## TOOL FOR TURNING CRANK SHAFTS.

*Editor* MACHINERY:

The tools and methods here described have been employed at the Western Iron Works, Los Angeles, for the past three years, during which time many more gas engine cranks have been turned out than could possibly have been produced with the same lathes using ordinary methods. Fig. 1 shows the jigs or dogs which are used to secure the cranks on centers. No great exertion is required to secure the crank in these jaws, yet once secured, there is no possibility of its slipping as the grip is positive and sure. Each dog consists of a hollow box casting in each end of which is cored a square hole through which the shaft is passed. This hole is placed diagonally with the line of shaft centers in order that a difference in the diameter of the shaft will not change the stroke of the crank. Of course in the same shaft both ends would be of the same diameter but this might vary in different shafts by a quarter of an inch, more or less, and yet have no effect on the stroke of the crank nor cause any difficulty in holding the work in the dog.

The first operation is to slip the dogs onto the ends of the crank and tighten the setscrews lightly on the shaft. Then adjust the screws in the ears, by eye, and put the work on

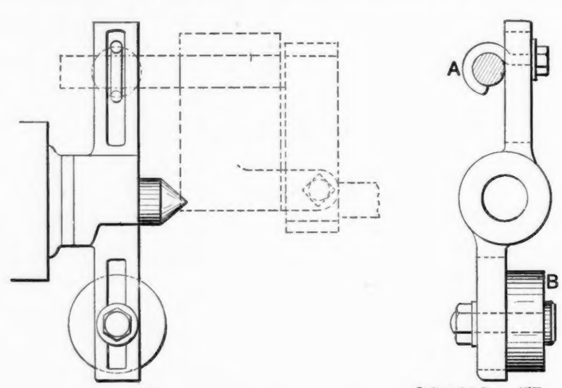


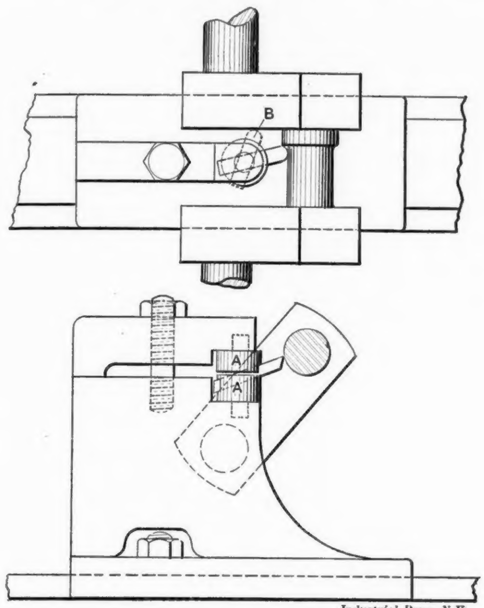

**Fig. 2. Method of Driving Crank Shafts.**

the lathe centers. Now, with the inside calipers, test the ends of the shaft by the lathe shears with the shaft and crank pin centers about on a level. This done, and the dogs properly adjusted, the shaft is ready for turning and with a good tool of self-hardening steel an opportunity is afforded for making a record in stock removing, for the jigs will stand any strain within the power of an ordinary engine lathe. When enough stock has been removed from the square rough forging to make the pin nearly circular, a larger flat will be found on one side than on the other. To the experienced eye this indicates that the stock was not properly divided and it is now in order to loosen the setscrews, in the ears, on the side of the large flat and tighten those in the opposite ears. Once more test the ends of the shaft by the lathe shears and proceed to finish turning the crank. The writer has also tried the use of the surface gage and face plate process for adjusting the stock exactly central in the first place, but experience has shown the method above outlined to be preferable because of its economy of time and greater degree of certainty.

In making these dogs a mid-center is placed between the pin and shaft centers to permit turning the ends of the crank cheeks, *a*, *a*, Fig. 1. Besides making a better looking crank, the saving of time in using a mid-center is fourfold over the usual practice of turning off the ends on the shaft and crank centers, respectively. In the first place, by swinging on mid-centers the cutting diameter is reduced to one-half, thus admitting of double the speed of the lathe, while by cutting both faces at one time another reduction of fifty per cent. is obtained.

For a driver for the cranks the writer devised the arrangement shows in Fig. 2. This screws onto the lathe spindle in place of a chuck, the object being to shorten the distance between centers, thereby stiffening the work. A hook bolt *A* secures the end of the shaft to the driver while on the other end of the driver is mounted the counterweight *B*.

Fig. 3 shows a special tool rest which takes the place of the usual long slender tool that reaches in between the cheeks of the crank. With this rest we get right up to the work with a piece of self-hardening steel ⅜ inch square




*Industrial Press, N.Y.*

**Fig. 3. Tool Rest for Turning Crank Shafts.**

and but about 2½ inches long. The thickness of this rest as made for a 36-inch lathe is 1½ inches, and the little collars *A*, *A*, are 1⅝ inches in diameter. They are slotted at an angle so as to secure rake to the tool without resorting to top grinding. Each collar has a teat to hold it central in position, the teats fitting holes in rest and clamp. The dotted lines at *B* show how the tool may be turned to work at any angle, at the same time retaining its top rake.

S. Byron Welcome.

Los Angeles, Cal.

## GOOD AND POOR MANAGEMENT.

*Editor* Machinery:

During my travels I have come across many cases of good and poor management. I remember one foreman who used to be always rushing about the shop, and if anyone asked him a question he would hardly take time to answer but he would rush away, maybe to go and "row" a man for some small mistake, or perhaps nothing at all. He was always so busy he never had time to plan the best way to get things done; I don't believe he ever thought about it at all. When anything was wanted he would give it to a machinist with instructions to do it as fast as possible, any way so long as it would "go" when done. He would give a man a job and a few hours later tell him to leave it and do another, and perhaps in a short time he would give him a rush job. Every man in the shop had about fifteen different jobs in hand, most of them about half finished; the shop was piled up with work, some of it just started, the greater part half-done, and there were signs of great activity among the workmen, most of whom were using a hammer and chisel, or dragging heavy castings around and making plenty of row, for the workman who wasn't making a big noise and scurrying around, wasn't working. Yet for all this the output of the shop was low, very low, and the office used to complain. This worried the foreman and he would go around and raise Cain till everything was in a whirl. Still things got worse, so he was finally discharged; he left saying: "I do not care who comes, they cannot make the men work any harder," and I guess he was right.

The next foreman did not try to make them work *harder*, all he got them to do was to work *faster*. In a short time one would hardly have recognized the shop; there was no excitement, the men were not running about, there was much less noise, the hammer and chisel were used less. A machinist was given some work to do with a general outline of how it was to be done, and it had to be done right; only very urgent jobs were allowed to disturb the systematic running of the shop, the men were not "rowed" at regular intervals to keep them going, and the output of the shop was high. This shows one of the mistakes a foreman often makes: he thinks he must keep everyone on the jump, and imagines that the more he can scare a man the more work he will do. This mistake is made by many superintendents also; they go around two or three times a day and jack up the foremen, telling them they do not get enough work done, don't know how to manage a shop, and leave in a huge temper; the foreman generally feels disgusted with the whole business and will not take any interest in it at all, or else gets scared and tries to make things hum. Anyhow both ways are failures.

I once knew a superintendent who would not order any stocks and dies for the machine shop. He said: "Manage without." He was trying to keep costs down, and everything that required a thread had to be cut in a lathe. In another shop, when a machine broke down, the superintendent said: "Just fix it temporarily, any old way so that it will run." He would not order new parts, and so kept repair costs down for over a year. By this time most of the machinery was in a patched-up condition, breakdowns began to be very frequent and this meant delays. As the expense of duplicate parts had been saved, the temporarily patched-up machines would not last long, and it became necessary to temporarily repair the temporary repairs. The breakdowns caused a considerable fall in the output, yet the machinists were working overtime, the cost of repairs was rising by jumps, and looked even worse because of the very low repair costs the previous year. The superintendent was consulted and these facts were pointed out with painful accuracy, and he was asked to explain why. When the cause was explained, his high reputation for economic work fell below par.

There was the manager at a place where there was no time system. The men used to come and go as they pleased and book their time in the way which suited them best. This kind of work showed up in the profit and loss accounts, especially in the loss column, so the manager planned and got up a first-class time system. The men did not approve of this, as they liked the other way best, and a letter threatening strike was sent to the president; he was scared, and let them have their own way, and the time system was dumped. Afterwards the president used to wonder why the superintendent had such poor control over the men.

Philadelphia, Pa. Geo. P. Pearce.

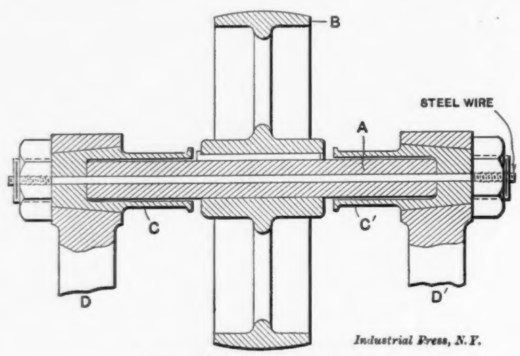
## CRITICISM OF THE GERMAN ANTI-FRICTION BEARING.

*Editor* Machinery:

In the February issue of Machinery there appeared an illustration and description of a new "anti-friction" bearing of German design. Ever since the appearance of this article I have been expecting to see some comment on the arrangement, and not having seen anything, I will ask to be allowed a little space in which to discuss this bearing, possibly to the benefit of some one who, attracted by the claims, might be tempted to make use of it for work to which it is in no way suited. The statement made in this article that "the smaller the diameter the less the frictional resistance to rotation," is somewhat misleading and should have been modified by adding "provided there is still sufficient bearing area to allow of proper lubrication." Frequently bearings of large diameter will run with less frictional resistance than smaller ones in which the bearing area is so limited that the oil is pressed out and a metal-to-metal contact results.

Now there is very little reason for thinking that the bearing in question is perceptibly better than a good steel pivot bearing. That the wire must be cut by shearing is *not* due to the tension, for the hub of the pulley is a good fit between the supports for the wire, and nothing but shearing action

could be produced, tension or no tension. The principal ground for criticism in this device is, I think, the claim that ample bearing surface is provided by the length of the wire. A little thought will show, however, that this is not so since the amount of bearing surface is practically independent of the length of the wire. Considering the case illustrated, where we have a 200 pound pulley running on a wire .016 inches in diameter. Imagine, if you can, a wire less than one-half of the size of a No. 60 drill supporting a 200-pound pulley; and also imagine that this weight is distributed equally over the whole length of the wire. It seems much more natural to suppose that as the pulley is run its hole will wear larger at the end and the wire will wear smaller where it emerges from its supports until it finally breaks under the shearing stress, while the greater part of its length will not be worn perceptibly. On examining the sketch it will not require very deep thinking to see that not only does the central portion of the wire fail to help support the pulley, but, on the contrary, it will bear on the wall of the hole opposite to the side upon which the power is applied.



German Anti-friction Bearing.

That the pulley runs easily there can be no doubt, but that does not prove that this is a practical device. Lubrication would be practically out of the question, a few simple figures showing that the pressure per square inch would be too high. I do not know how easily our German friends are aggravated but on this side of the "Pond" we would hardly consider it profitable to be obliged to have a coil of wire handy and to supply a new bearing at frequent intervals simply to eliminate a little friction. CORNEIL RIDDERHOFF.

Grand Rapids, Mich.

[For the purpose of making the above contribution more readily understood we have reproduced the illustration that was published, with the description of the bearing, in the February issue.—EDITOR.]

## THE CONSTRUCTION OF A SUB-PRESS DIE.

*Editor* MACHINERY:

Owing to the large number of parts of which a sub-press die is composed its first cost is, of necessity, much higher than that of an ordinary die. When, however, we consider that a sub-die, when properly made, will run ten hours per day for weeks at a time, without grinding, the first cost sinks to a minimum. In using an ordinary double die it is absolutely impossible to obtain two blanks that are exactly alike, one reason being that the stock to be punched is more or less wrinkled and does not lie flat on the face of the die. The consequence is, therefore, that after the piercing punches have perforated the wrinkled stock, and it is then flattened out, there is a greater distance between the holes than there is between the punches. Also, the pilot pins that are depended upon to locate the stock cannot do so exactly since they are made a trifle smaller than the piercing punches in order to prevent them from pulling the blank up out of the die. On a certain class of work the double die answers all purposes, but when accuracy is required a sub-die is the only one that will give satisfaction.

In order to avoid a complicated drawing and to set forth the plans of a die that may be readily understood by those not familiar with sub-dies, the writer has selected for illustration the die used for punching an ordinary washer; the general principles of sub-dies being the same whether one or one hundred punches are employed. Having selected a frame with its proper cap, of size suitable to the work, it is placed in a chuck, being held by the upper end and, having faced off the bottom, the recess at *A A* is bored to fit snugly the corresponding step on the base of the press. This base is finished on both top and bottom with a step above referred to turned to fit in the bottom of the frame. A slot at *G* is cut in each end to receive the finger straps by means of which the frame is fastened to the faceplate. The center is recessed to receive the stripper plate and blanking punch and a hole is drilled completely through to allow scrap punchings to fall to the floor. The base and frame are then fastened together by means of tap bolts and dowel pins as shown in the sectional view of the press. Together they are clamped to the faceplate, being centrally located by means of a plug center which fits the taper of the lathe spindle and passes through the hole in the center of the base. In this position the frame is bored out to a taper of about one-half inch per foot. After boring, a splining tool is substituted for the boring tool and, with the lathe locked by means of the back gears, three or four grooves, *B, B*, are cut the entire length of the bore by sliding the carriage back and forth. At the same setting the upper side of the frame is faced off and threaded to receive the cap which is screwed on the frame, then the hole for the plunger is bored out to the required size. This insures the hole in the cap being central with the inside of the frame.

The plunger, shown in detail in Fig. 2, is the next piece to receive consideration. After being centered and rough turned, it is put in the center rest and the hole *C* bored and threaded and fitted with the button shown in Fig. 3. This threading is carried down to quite a depth in order to allow of the insertion of a tension cap, Fig. 4, by means of which a sufficient tension is placed upon the stripper spring to force the punching back into the stock upon the return stroke of the press. A dog is fastened to the button and the plunger turned to fit the hole in the cap, great care being exercised to keep the sides perfectly parallel. After turning, the lathe is blocked by the back gear, and three grooves *E, E, E*, are splined, about 1-16-inch deep, for the entire length. It is essential that these grooves be parallel with the axis of the plunger. Before the plunger is completed a ring three-quarter inch wide, is made of machine steel and forced onto the lower end of it. The outside of this ring is trued up, using the plunger as an arbor, after which this end of the plunger is placed in the center rest where the ring prevents it from being scored or injured by the center rest. In this position the recess seat *F* is bored out to receive the punch holder shown in Fig. 5.

The punch holder is made, as are also the die stripper and punch, Figs. 6 and 7, by turning from a bar held in the chuck and finishing complete before cutting off. The recess which receives the head of the piercing punch should be bored at the same time to insure its being central with the tool-holder. The stripper, Fig. 6, should be made of tool steel and left large to allow for grinding after hardening, while the hole is bored sufficiently small to allow for lapping to exact size. The blanking punch, Fig. 8, which also contains the piercing die, is made of tool steel in the same manner, being finished complete before it is cut off and it is left with sufficient stock to grind after it has been hardened. The holes *H H* are drilled and counterbored for screws to hold the punch to the base.

After the parts are hardened the blanking die is the first to be ground. It is gripped in a chuck, bottom end outward, and the large hole *J* is ground out to fit the step *K* on the punch holder. Then the hole *L* is ground perfectly straight and of the same diameter as the master templet. The bottom is also ground off, thus completing the die. In the stripper the hole *M* is lapped to the same dimension as the master templet. A round piece of cold rolled steel is gripped in a lathe chuck and turned to fit nicely this hole in the stripper. Without disturbing the chuck, wring the stripper onto this arbor and grind the flange or shoulder *N* to fit nicely the larger bore, and the smaller diameter to fit the smaller bore, of the die. The blanking punch is finished in exactly the same manner as the stripper, being ground to fit the re-

cessed seat in the base. The minor parts such as the stripping plate, stripper piston, pins and springs are then made and the press is ready to assemble.

In assembling, first force the punch holder, Fig. 5, into the seat *F* of the plunger and then force the die onto the holder; transfer the holes in the die through the holder and into the plunger and after they are drilled and tapped, fasten the parts together as shown in the sectional view. Remove die and drill four holes in the punch holder and plunger for the stripper pins *O O*. Place the stripper piston in the plunger, above this the spring, and lastly screw the tension cap into place. The stripper pins *O O*, which are hardened for their entire length, are placed in their holes in the punch holder and the stripper placed in the die, which is then secured in its place on the punch holder.

The blanking punch is placed in its seat in the base and securely fastened by the cap screws, after which the springs are placed in position and the stripper plate drawn down, by means of the screws *P P*, until it is a trifle below the top of the blanking punch. When the die is fastened to the frame it is ready to be babbitted. Screw the button onto the plunger and with a piece of oily cloth wipe the plunger all over, then sprinkle flake graphite onto it. The oil on the plunger will cause the graphite to adhere and after the surplus has been blown away a thin coating will be left over the entire surface. The plunger is lowered inside of the frame until the blanking punch enters the die. In the cap insert the ring shown in Fig. 9, to prevent babbitt from flowing into the recess *R*, and screw the cap onto the frame. As the cap is an exact fit for the plunger it therefore aligns it with the frame and with the blanking punch. The grooves on the plunger must be plugged with putty where they pass through the cap in order to prevent the escape of the babbitt while pouring. A pair of parallels, of a height equal to the projection of the button beyond the top of the cap, are now placed on the bench and the die inverted upon them. Great care should be taken to avoid any vibration during pouring as very little will affect the alignment of the plunger, so that it is better to do the babbitting at the noon hour or at such other times that the power is not running. Before pouring, heat the frame with a torch or jet of gas and when the babbitt has attained the proper heat, which is a very dark red, pour it in from both sides of the die simultaneously. Allow it to remain until thoroughly cool, then remove the plunger, strap the frame to the faceplate of a lathe and cut a spiral oil groove the entire length of the babbitt.

As the blanking punch has already been ground the next step is to grind the faces of the blanking die, piercing punch, and stripper, while all are in their proper positions in the plunger. They should be ground so that the face of the stripper, die, and punch are all flush with each other. After grinding, the parts should be taken from the plunger and thoroughly cleaned so that no emery can possibly remain in the working parts. Oil all of the running parts in a thorough manner, then put them together in their proper positions and replace the plunger in the frame. In setting up a sub-die care should be taken to have the punch come to the face of the die only and not enter it.

Frank E. Shailor.

New Haven, Conn.

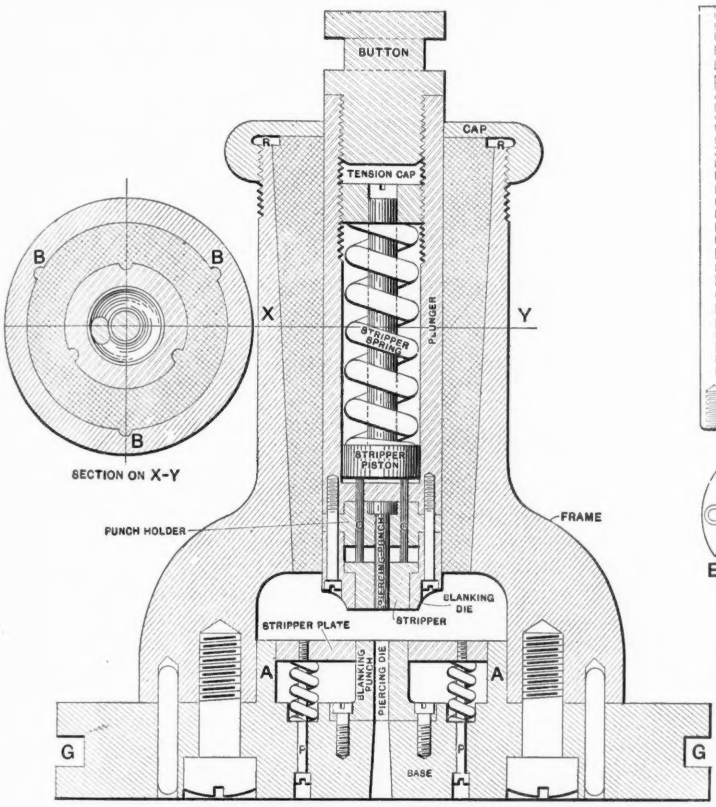
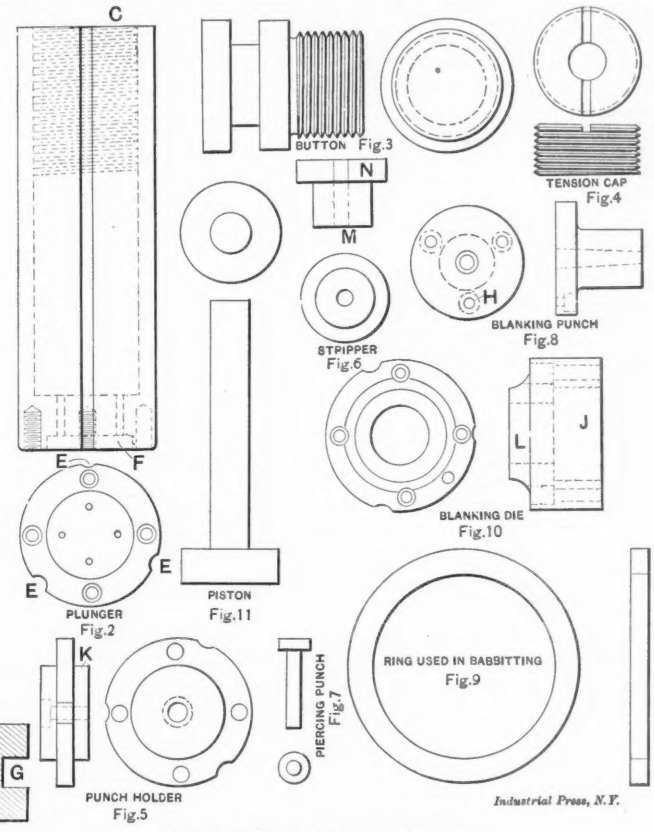



Fig. 1. Section through Sub-Press.




Details of Parts Composing Sub-Press.

* * *

A writer in *Dixie* imparts some interesting information regarding the combustion of certain compounds. It is the common practice of engineers to estimate the calorific value of a fuel from its chemical composition, and, generally speaking, the figures so obtained are accurate. There are exceptions, however, where this method will not give correct results, and acetylene is one of them. Certain foodstuffs, as starch and sugar, show the same peculiarity, their heat of combustion differing widely from that estimated from their chemical composition. The chemical composition of acetylene is given by the formula $C_2H_2$, so that 13 pounds of the gas consists of 12 pounds of carbon and 1 pound of hydrogen. The perfect combustion of 12 pounds of carbon to carbonic dioxide will give 174,000 heat units, and 1 pound of hydrogen burned to $H_2O$ will liberate 62,000 heat units, making a total of 236,000 heat units. Actual measurement, however, shows that the heat set free by the combustion of acetylene, is 281,250 units, or nearly one-fifth more than would be calculated from its composition. The heat of combustion of cyanogen ($C_2N_2$) is nearly one-third more than that calculated from its carbon contents. The explanation for this discrepancy is found, of course, in the fact that a large quantity of energy is absorbed in the formation of these compounds which is liberated in the form of heat on burning them. It is this fact that gives acetylene an element of danger as an explosive; for, apart from any question of combustion, there is a large store of energy available for destructive purposes by the mere decomposition of the gas into its elements.

## THE THEORY AND APPLICATION OF THE PRINCIPLES OF ISOMETRIC DRAWING.

A. B. BABBITT.

This article is written to give both the theory and practical application of isometric drawing. To those who have a knowledge of orthographic projection, the theoretical portion may be of value, while all engaged in mechanical drawing should derive some benefit from the practical treatise of the subject.

### Theory.

Let us imagine a cube with its bases parallel to a horizontal plane and its lateral faces making angles of 45 deg. with a vertical plane. Three views of this cube, top, front and side, are shown in Fig. 1. Draw *AB* the diagonal of the cube. Revolve the side view until the diagonal *AB* is horizontal, as shown in Fig. 2, and obtain the front view which will be the isometric drawing of the cube.

By studying this view carefully, it will be noticed that all lines of the cube are either vertical or 30-deg. lines and that the foreshortening of these lines is exactly the same in each case. The ratio of lengths of lines in the isometric to those in the orthographic drawing may be found in the following manner:

In the top view of Fig. 1, we have the edges of the cube shown in their true lengths, while in the front view, Fig. 2, the edges are shown in their isometric lengths. In the top view, Fig. 1, the true length is shown on a 45 deg. line, while in the front view, Fig. 2, the isometric length is given on a 30-deg. line, the difference between the two angles being 15 deg.

It is perfectly obvious, then, that if we construct a triangle having the sides equal in length to the lines of the views already referred to and the included angle 15 deg., we may very easily find the ratio of one to the other. See Fig. 3. By laying off a standard scale on *AB*, the isometric scale may be obtained by drawing parallels to *BC* as shown in Fig. 4.

### Practical Application.

#### Rules.

1. The lines shown in Fig. 5 are called isometric axes. They consist of a vertical line and two lines at 120 deg. with the vertical, drawn to the right and left from one common point.
2. These lines or axes represent lines mutually perpendicular, as the corner of the cube shown in Fig. 2.
3. All measurements must be laid off full size on or parallel to these axes.
4. All vertical lines of the object will be vertical in the drawing and all horizontal lines of the object will be 30 deg. lines on the drawing.
5. Lines parallel in the object will be parallel in the drawing.
6. Right angles on the object are usually represented by either 60 deg. or 120 deg. on the drawing.

To apply these principles to the drawing of a rectangular prism, proceed as follows: Use the line *MO* shown in Fig. 6 as a vertical edge of the prism and let this coincide with the vertical isometric axis. See Fig. 7. The line *MS*, a horizontal line of the object will be represented by a 30-deg. line drawn from *M'* to the right a distance equal to the length of the line *MS*, Fig. 6, and shown at *M'S'*, Fig. 7. The line, *LM*, Fig. 6, will be shown at *L'M'*, Fig. 7, drawn to the left from *M'* a distance equal to *LM*, Fig. 6. We now have the lines *M'O'*, *M'S'* and *M'L'* coincident with the axes shown in Fig. 5 and representing lines mutually perpendicular.

To complete the surface *LMNO*, draw (Rule 5) *N'O'* parallel to *L'M'* and *L'N'* parallel to *M'O'*. To complete the surface *MSOP*, draw (Rule 5) *O'P'* parallel to *M'S'* and *S'P'* parallel to *M'O'*. To complete the upper surface of the prism, *S'X* must be drawn parallel to *M'L'* and *L'X* parallel to *M'S'*. To complete the prism and show all invisible edges, *XY*, *YP'* and *YN'* should be drawn parallel, respectively, to *S'P'*, *S'X* and *L'X*.

If we make all lines of this isometric full size, as called for in Rule 3, the drawing will appear considerably larger than the object. To avoid this, an "isometric scale" may be made by using the method shown in Fig. 4. This will make the drawing appear nearer the size of the object.

### Drawing Irregular Outlines.

To make the isometric drawing of the irregular solid shown in Fig. 8, proceed as follows: It is necessary to remember that measurements can only be made on or parallel to the isometric axes, and that these axes represent lines mutually perpendicular. To draw the oblique lines *HG* and *KG* in isometric, it will be necessary to determine the points *H*, *G* and *K* by means of measurements parallel to the isometric axes.

Produce the line *KL* to *P* and line *HF* to *P* and make the isometric drawing of the rectangular prism having one face *LPFE*. Such a prism is shown in Fig. 9. Measure off on *PL* the distance *KL*, giving the location of the point *K*. Lay off on *FP* the distance *FH*, giving the location of the point *H*. To obtain point *G*, lay off from *P* the distance *PS*, Fig. 9, equal to *PS*, Fig. 8, and draw *SG* parallel to *PK*. Make the distance *SG*, Fig. 9, equal to *SG*, Fig. 8. Having given the point *G*, *HG* and *KG* may be drawn and the irregular solid completed by drawing *GG'* parallel to *HH'* and *H'G'* and *G'K'* parallel, respectively, to *HG* and *GK*.

The method of finding the vertex of a pyramid is shown very clearly in Fig. 10. The points of the hexagonal base were obtained from the construction lines shown. Dotted lines and letters correspond in Figs. 10 and 11. The vertex is found by finding the center of the base by diagonals and measuring the altitude on a vertical line drawn from this point.

### The Isometric Circle.

To draw the isometric circle, first draw the isometric of a square of a diameter equal to the diameter of the circle. Shown at *ABCD*, Fig. 12. Draw *AC* and bisect the sides of the square by means of diameter *ef* and *gh* drawn through the center. Draw *Dg* and *Df*. With *B* and *D* as centers and with a radius equal to *Dg*, draw arcs 1 and 2. With *m* and *n* as centers and with a radius equal to *mf*, draw arcs 3 and 4, thus completing the isometric circle.

The application of the isometric circle to the drawing of cylinders and cones is illustrated in Figs. 13 and 14.

* * *

## THE NEW EXPLOSIVE, "HATHAMITE."

The danger attendant upon the use of dynamite is too well known to require comment, and because of this imminent danger not only to the users but the general public the invention of safe high explosives that will do the work of dynamite should be of general interest. Several high explosives have been heralded that are claimed to be much safer than dynamite and among them is "hathamite," the invention of the late George M. Hathaway, Wellsboro, Pa. A final test was made of "hathamite" at Wellsboro, May 2 (three days after Mr. Hathaway's death) in the presence of a number of capitalists and experts, with results that are reported to be very satisfactory and little less than wonderful. When properly detonated the compound explodes with terrific violence, having all the characteristic effects of dynamite. A piece of steel boiler plate 9-32 inch thick was laid on a steel block having a 2-inch hole. Two ounces of "hathamite" were exploded on top of the boiler plate over the hole in the block, and a 2-inch hole was found punched cleanly in the plate. Then a quantity was melted over an oil stove and poured like molasses into shallow tin boxes. When it hardened one of these boxes was set up as a target and a steel rifle ball shot through it without exploding the contents of the box. Then the remains of the cast explosive were taken into a mortar and pulverized with a pestle and after being subjected to hammering and grinding, the powder secured from this was again placed on a steel boiler plate and a hole punched through it, as before, showing that the quality of the compound had not suffered by melting, casting and again being reduced to powder, besides demonstrating its safety. One-pound, three-pound and six-pound steel shells were filled with the explosive and exploded in a large steel chamber producing wonderful fragmentation. Beside some of the shells exploded in the steel chamber were placed other loaded shells which did not explode from the violent concussion given them. The only way it can be exploded is by means of a detonating cap giving flame and concussion at the same time.

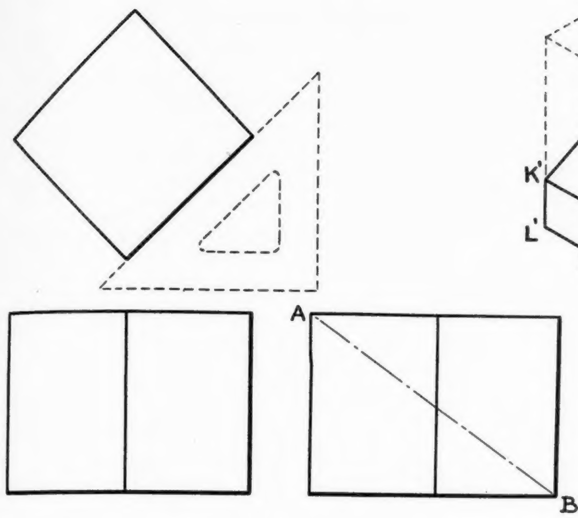



FIG. 1.

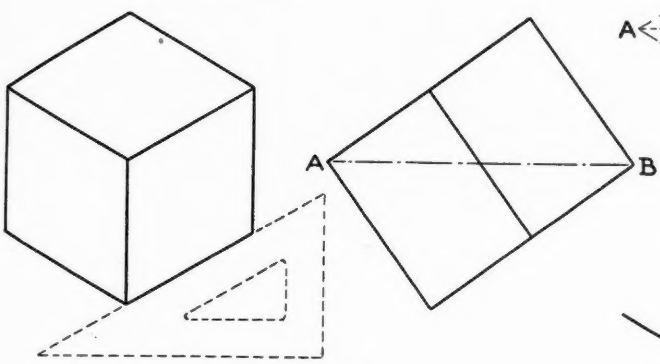



FIG. 2.

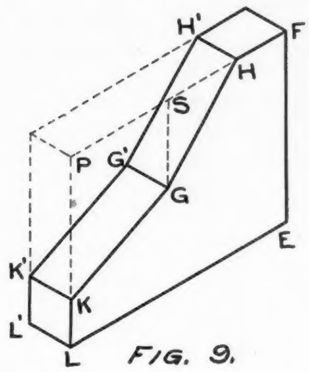



FIG. 9.

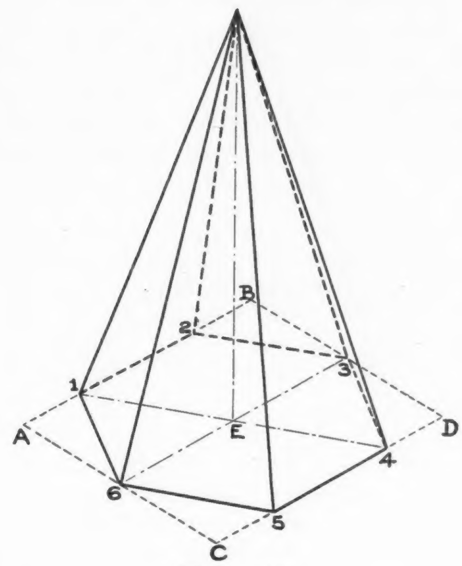



FIG. 10.

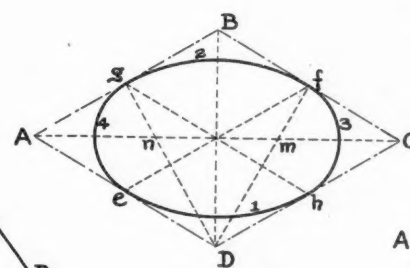



FIG. 12.

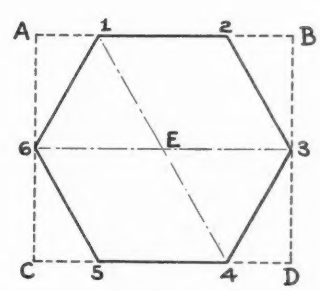



FIG. 11.

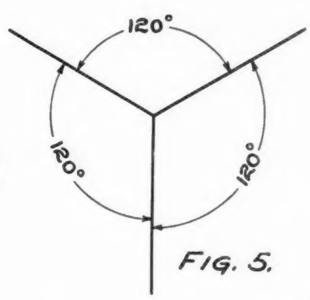



FIG. 5.

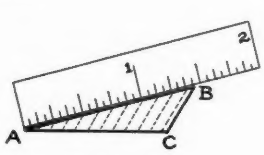



FIG. 4.

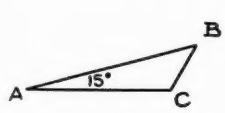



FIG. 3.

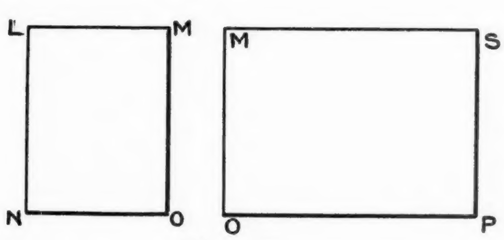



FIG. 6.

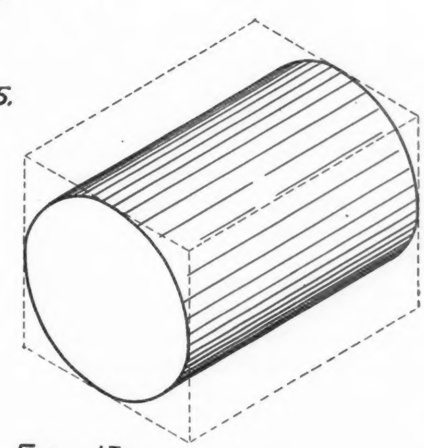


FIG. 13.

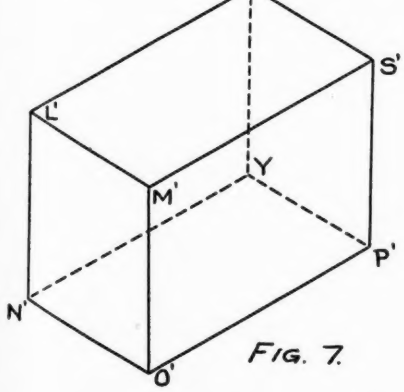



FIG. 7.

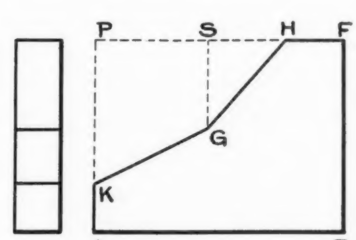



FIG. 8.

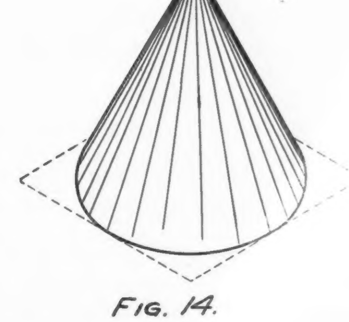


FIG. 14.

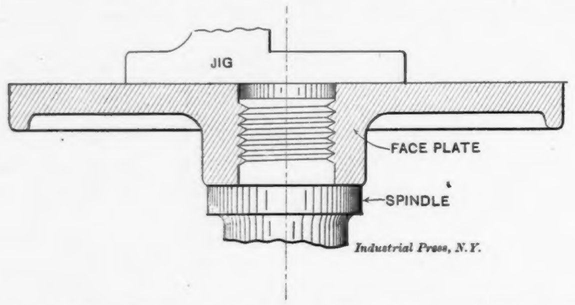
INDUSTRIAL PRESS, N.Y.

APPLICATIONS OF THE PRINCIPLES OF ISOMETRIC DRAWING.

## CONTRIBUTED NOTES AND SHOP KINKS.

### LOCATING JIGS ON THE FACEPLATE.

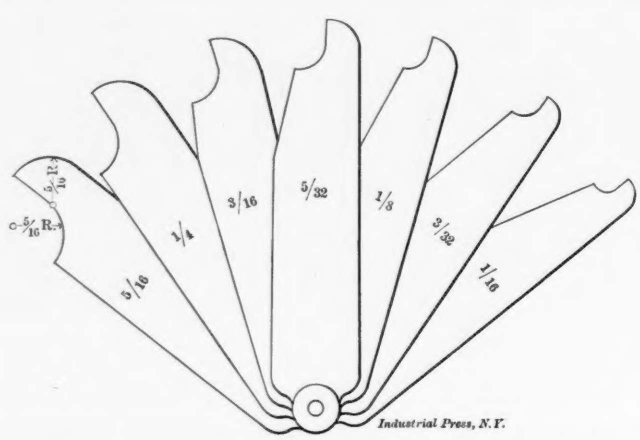
Commenting on a recent kink by George Henry, in which he advocates recessing the faceplate for locating jigs in the lathe, Francis Shaw writes: A simpler way is to turn out the first few threads in the faceplate hole, as shown in the




sketch. This will in no way mar the plate and will accomplish the accurate location of the jig in exactly the same manner as described by Mr. Henry.

### A RADIUS GAGE.

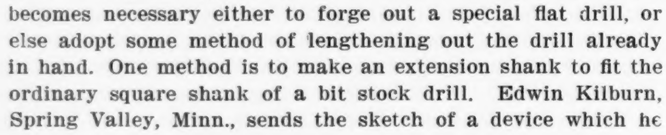
A. Putnam sends the sketch of a home-made radius gage which has proved to be very handy for all such work as rounding corners or grinding tools to a given radius. The blades are of thin steel and are fastened together at the end by a rivet, thus forming a tool similar to the familiar screw pitch




gage. The right-hand corner of each blade is rounded off to the given radius, while the left-hand corner is cut away at the same radius, thus fitting the instrument to be used for either convex or concave surfaces. The radius to which each blade is shaped is plainly stamped upon the side.

### AN IMPROMPTU EXTENSION DRILL.

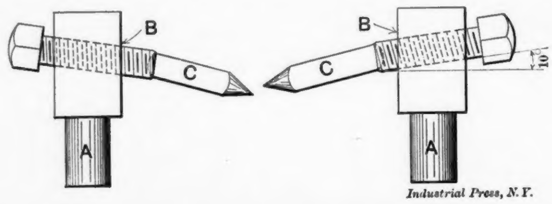
It often happens that it is desired to drill a hole or holes in a place which the ordinary length of twist drill with either a round or square bit stock shank will not reach; it then becomes necessary either to forge out a special flat drill, or else adopt some method of lengthening out the drill already in hand. One method is to make an extension shank to fit the ordinary square shank of a bit stock drill. Edwin Kilburn, Spring Valley, Minn., sends the sketch of a device which he




recently made for this purpose and which proved very satisfactory. The body part *B* was made of a piece of steel tubing ½ inch outside diameter, which was brought to a red heat for about 1 inch at one end, and this end was driven down over the shank of a drill held in a vise. A very little hammering made a first-class square socket and one which exactly fitted the drill. To enable the device to be used in a bit stock a shank which had been broken off a drill and which was of the right size to fit inside the tubing was brazed in as shown at *A*. This made an extension holder which held a drill almost as rigidly as though it were a solid piece and also possessed the further advantage that it was little, if any, larger in diameter than the drill, a point which is many times as much of an advantage as the increased length.

### HANDY PLANER AND SHAPER CLAMPS.

"Toolmaker" sends the sketch of a style of planer clamp which he recently found very convenient for holding some long, narrow pieces that could not be handled in a chuck or held down by straps. Some pieces of iron or steel 1½ inch square by 5 inches long were turned down at *A* to fit the holes in the platen of the planer. At *B* a hole was tapped, at an angle of 10 degrees with the horizontal, and fitted with a ⅝-inch cup-pointed setscrew. Pieces of square, self-hardening steel were cut in lengths of about 2½ inches and a point,




similar to that on a center punch was ground on one end. The other end was ground round to fit the cup point of the setscrew. These pieces are placed with their pointed ends against the work and the other ends in the cup of the screws as shown in the sketch. In this way the work is held very nicely. If the marks caused by the points will injure the work, a piece of sheet metal can be placed between the work and the point. The marks, however, will be slight, as the clamping force required to hold the work firmly is very small.

### MILLING ANY ANGLE.

Robert A. Lachmann, informs us of a very neat "kink" recently brought to his notice for milling flats on shafts, or similar work, whereby the proper angle can be obtained by movement of the milling head without the use of a bevel protractor. The scheme consists simply in setting the sector for three holes on the 27 circle. It is obvious that a movement of three holes on the 27 circle (with a worm and gear whose ratio is 40 to 1, as is generally the case) will give 1-360 of one revolution of the work, or a movement of 1 degree, so that any angle can be accurately cut by this method. For example, if a movement of 9 degrees is required, one full turn of the indexing crank will be required, since 27 ÷ 3 gives 9-360 of a complete revolution of the work or a movement of 9 degrees. Similarly, 10 turns of the indexing crank will give 90 degrees which would be used when milling a square.

### SHOP USE FOR PLASTER OF PARIS.

J. B. C. writes: It is doubtful if you would find plaster of Paris in many machine shops at which you might inquire for it, yet it has frequent utility. Fig. 1 shows the section of a thin casting which is to be finished on the inside and outside while Fig. 2 represents, exaggerated, the shape which it assumes when secured in a four-jaw chuck. Of course the work will not be round when it is removed from the chuck. If the

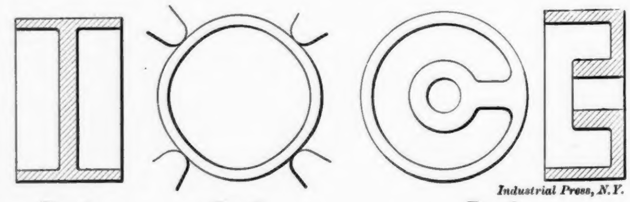



Fig. 1 Fig. 2 Fig. 3

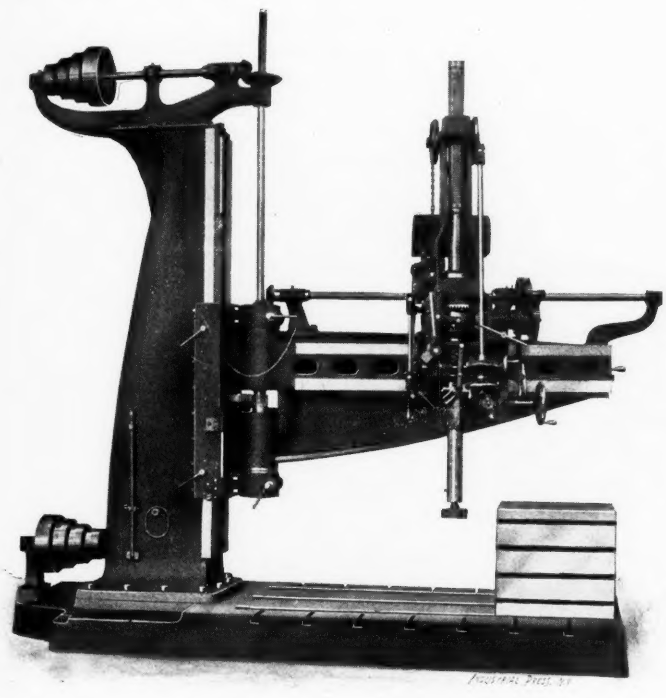
side to be chucked is filled with plaster this difficulty is avoided. Fig. 3 is the expansion member of a clutch and is to be turned on an arbor. However slowly and carefully this turning is done the work will chatter and the finished piece will be neither round nor concentric. Here again plaster eliminates the difficulty and allows the turning to be accomplished with ease. After the work is finished the plaster can be readily broken up and removed.

# NEW TOOLS OF THE MONTH.

## A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

### SEVEN-FOOT TAPPING RADIAL DRILL.

The Fosdick Machine Tool Co., Cincinnati, Ohio, have recently brought out a 7-foot tapping radial drill that is especially adapted to locomotive works, railroad shops, and shops of like character where unusually heavy drilling and tapping are done. This drill is capable of drilling to the center of a 172-inch circle while the greatest distance from the spindle to the base is 90 inches. One of the distinctly new features of the machine is that it has a positive thread-cutting attachment for 8, 10, 12 and 14 threads per inch, for heavy tapping, and four positive geared drilling feeds. The spindle has a traverse of 30 inches and is counterbalanced to facilitate operation.



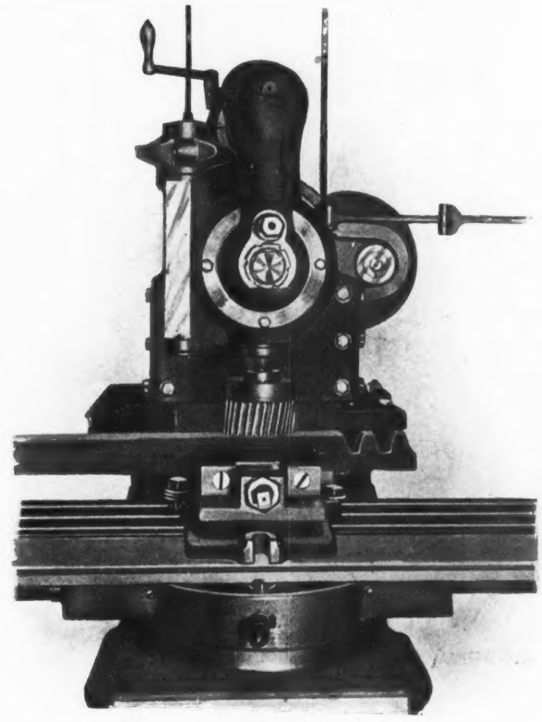
Special Seven-foot Radial Drill.

The back gears are located in the head, thus bringing the power direct to the work. All operating levers are located on and travel with the head and are therefore always directly in front of and convenient to the operator. A quick return permits of engaging the power feed instantly. The various special features of this machine make it capable of taking care of certain classes of large work, heavy drilling, tapping, etc., to much greater advantage than is possible with the plain radial drill. In the locomotive works these drills are being used on heavy drilling, reaming and tapping especially on cylinder guide yokes, link hangers, rockers, cross heads, etc., also for hubbing off the bosses on rocker arm hubs, link hanger hubs, valve gear transmission rods, etc., with a box tool.

### ATTACHMENT FOR MILLING SPUR GEAR RACKS.

James & Foote, Chicago, Ill., have just brought out the milling attachment illustrated herewith, which is designed for milling the surface of spur gear racks and cutting the teeth in them. It is capable of using large face mills and will carry rack cutters up to 2 diametrical pitch. The attachment is secured to the frame of the milling machine by a saddle clamped to the vertical ways. This saddle has an annular T-slot provided with bolts which clamp it to the milling head but at the same time allow the head to be swung around at any angle, the position being indicated by a set of graduations on the base.

The horizontal shaft is inserted in the cone spindle of the milling machine and from this the vertical shaft of the attachment is driven, through a pair of miter gears which allow it to swing through the whole circle. The end of this vertical spindle is threaded to fit the same chuck as the machine spindle and is reamed to Brown & Sharpe No. 10 taper. The rack cutting spindle is driven by steel spur gears and fitted to carry Brown & Sharpe standard rack cutters. After milling the surface of the rack with an end mill, as shown in the illustration, the head is swung around, through 90 degrees, so that the rack cutting spindle, shown here in a vertical position, will be brought horizontal and the teeth of the rack are then milled in the ordinary manner.



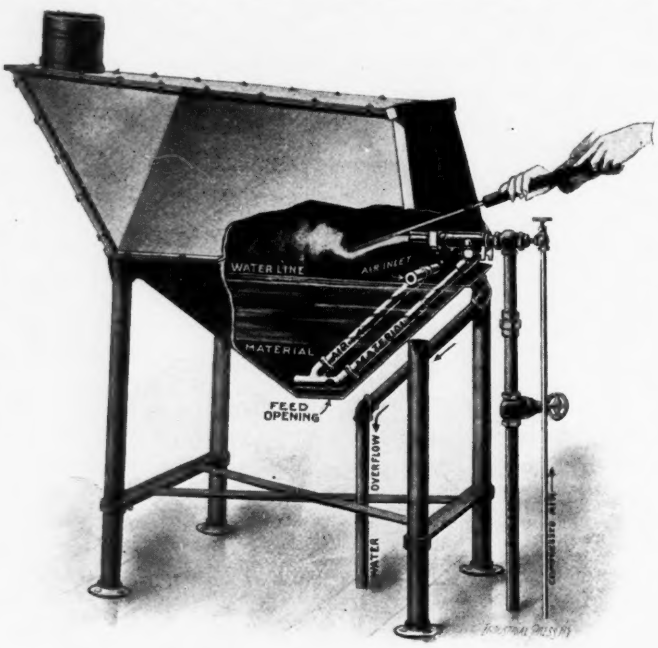
Attachment for Milling Spur Gear Racks.

### A FILE SHARPENING MACHINE.

Owing to the fact that as a rule the cost of files goes into the miscellaneous shop expense and thereby loses its individuality, very few manufacturers realize what a large source of expense their files are to them. A file is different from any other edge tool in that it can only be used for a short time before an infinitesimal portion of the head of the teeth becomes worn off and the file, for all practical purposes, becomes worthless although in all respects except its cutting qualities it is as perfect as ever. Many manufacturers then throw their dull files on the scrap pile, unless they have them recut which is often unsatisfactory on account of the temper and size being changed. But they do not throw away their other edge tools when they become dull; they sharpen them up again. Since the first files were made, experiments without number have been tried whereby a dull file could be restored to its original usefulness without changing its size or temper, and thus rendered suitable to be used again.

The illustration herewith shows a new machine for this purpose which is the invention of Mr. A. H. Radell, and is being placed on the market by the American Steel Tool Co., Chicago, Ill. The machine is operated by means of steam alone, or a combination of compressed air and steam may be used. By means of a suction blast the abrasive material, which is carborundum, is forced against the back of the teeth of the file at an angle of from 15 to 30 degrees. The file is drawn up and down over a nozzle inside of which is a reducing jet so that the material strikes the teeth from the back and cuts away a portion of the metal wherever it has a point of resistance, thus restoring to the file its sharp-

ness and cutting qualities and preserving the original angle of the tooth. This treatment does not disturb the temper of the file nor does it perceptibly alter its size. On account of the angle at which the file is held and at which the abrasive material strikes it, the point of the tooth is protected since the material travels up the back following the original angle of the tooth instead of striking directly and so dulling it. After impinging against the file, the material settles to the bottom of the machine and is used over

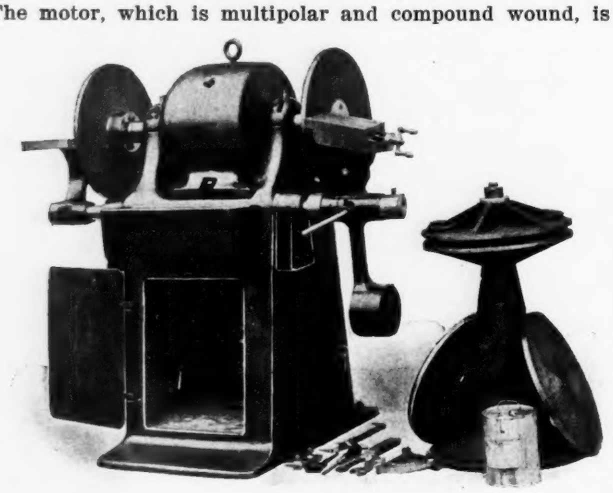



Machine for Sharpening Worn Files.

and over again until it is gradually cut up and carried away in solution by the overflow outlet. With this machine it is possible to sharpen 100 to 300 files per day, of all shapes and sizes. Ordinary files may be sharpened from two to six times, according to the depth of the tooth, and they may then be recut in the ordinary way and used and sharpened as many times more.

### UNIVERSAL MOTOR-DRIVEN DISK GRINDER.

The Ransom Mfg. Co., Oshkosh, Wis., have just brought out an 18-inch universal motor-driven disk grinder which is illustrated herewith. The armature of the motor is wound on a sleeve which is pressed onto the spindle of the machine. The motor, which is multipolar and compound wound, is of



Motor-driven Disk Grinder.

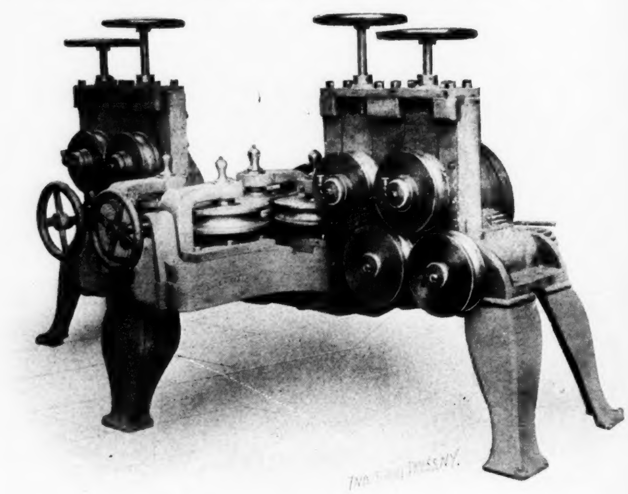
the enclosed type, the enclosure being accomplished by means of spun copper hoods the upper half of which can be removed when it is necessary to adjust the brushes. The shaft carries on each end a grinding disk and the end play is taken up by means of jam nuts which are placed on each side of the left hand box. Heretofore the practice has been to place the jam nuts on the inside of each box but this was found to have the objection that as soon as the armature shaft became a little warm it would expand and crowd the nuts against the inside of the boxes, causing them to cut. By the present arrangement this trouble is entirely overcome.

A table is provided for each disk, that on the right hand end of the machine being universal in that it can be set at any angle. It has a screw feed toward the wheel and swings, on a shaft, across the face. This table is provided with T-slots so that any kind of templets or gages may be attached without the necessity of drilling holes in the table for this purpose. The machine is accompanied by a press and all of the accessories needed for preparing the grinding disks.

### SHAFT AND TUBE STRAIGHTENERS.

Kane & Roach, Syracuse, N. Y., are placing on the market a full line of straightening machines which were designed by Mr. W. E. Kane for rolling mill use. The outside rolling machines, which are built in four sizes, have a capacity for straightening angles from 2 x 2 x 1/4 inches up to 4 x 4 x 1/2 inches, and up to No. 40 railroad rails. They have eight rolls and are geared for two changes of speed.

The four sizes of inside rolling machines have overhanging shafts for extra outside rolls. They are built with either eight or nine rolls, the nine-roll machines having overhanging rolls on each end, can be run in either direction. These machines are built for either belt drive or direct connection with motor or engine, and in either case they are geared for two changes of speed. The capacity of the inside rolls ranges from 5 x 5 x 5/8-inch angles up to 7-inch round stock.



Shaft and Tube Straightening Machine.

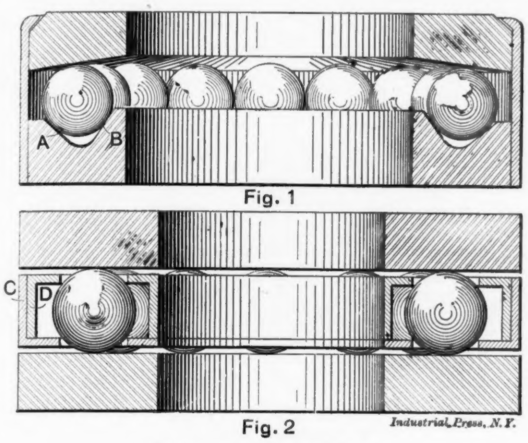
The latest addition to this line of straighteners is the tube and shaft straightener illustrated herewith. These machines have twelve rolls, eight vertical and four horizontal, and they are built very long so as to have nearly a whole bar of shafting or tube in the rolls at one time. These machines range in capacity from 1-inch to 3-inch shafts and from the smallest tube up to those 8 inches in diameter. They are arranged for two changes of speed and may be driven by belt power or be direct connected.

### NEW LINE OF THRUST AND RADIAL BALL BEARINGS.

The recently organized American Ball Co., Providence, R. I., have brought out a complete line of anti-friction bearings, including both thrust and radial ball bearings. The thrust bearing shown in Fig. 1, was designed to meet various requirements where it is desired to support the axial thrusts of shafts, the aim being to construct a bearing in which there would be rolling contact only between the balls and the raceways. The two points of contact *A* and *B*, on the lower plate, are in such a position in relation to the axis of the shaft that the rolling contact circles on the balls are in the same proportion as the contact circles on the plate. The contact on the upper thrust plate is in a plane parallel to a line drawn through the two points of contact on the lower plate, and it is therefore evident that no sliding will take

place between the balls and the plate. The tendency to force the balls outward, on account of the difference of the angles of the lower plate, is counteracted by the angle of the face of the upper plate forcing them in the opposite direction.

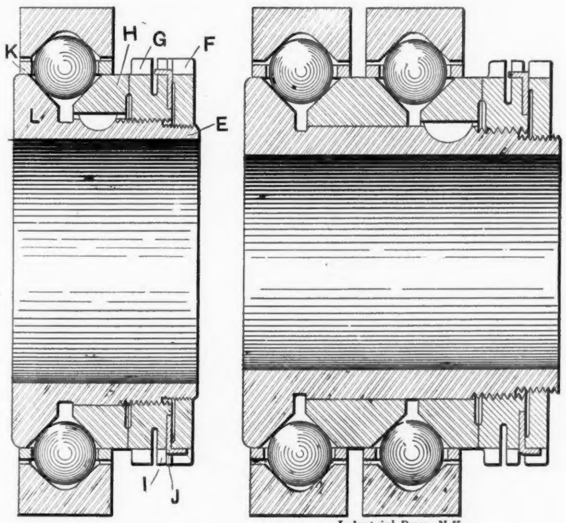
Fig. 2 represents the simplest form of thrust bearing, the principal point of novelty being the ball retaining cage. This is made of machinery steel and consists of two parts, an outer and inner cup, *C* and *D*, which are pressed together after the balls are placed between them. The thickness of the cage is nearly equal to the diameter of the balls contained in it,




"Reid" Ball Thrust Bearings.

so that sufficient metal is left between the holes for strength while at the same time the balls are as close together as when no cage is used.

In the application of radial ball bearings to machinery it has generally been necessary to make all parts of the bearing special or an integral part of the machine to which they are applied. Fig. 3 shows a sectional view of a single unit radial bearing that is self-contained, capable of adjustment for wear, and designed to cover a wide field of application. The lock nut, by means of which the adjustment is accomplished, is one of the especial features of the bearing. It is composed of an extended sleeve support *E*, formed with screw threads of opposite pitch, and the co-acting nuts *F* and *G* both of which are resilient in an axial direction at their contact portions. The inner face of the nut *G* is presented




Figs. 3 and 4. One and Two Unit Radial Ball Bearings.

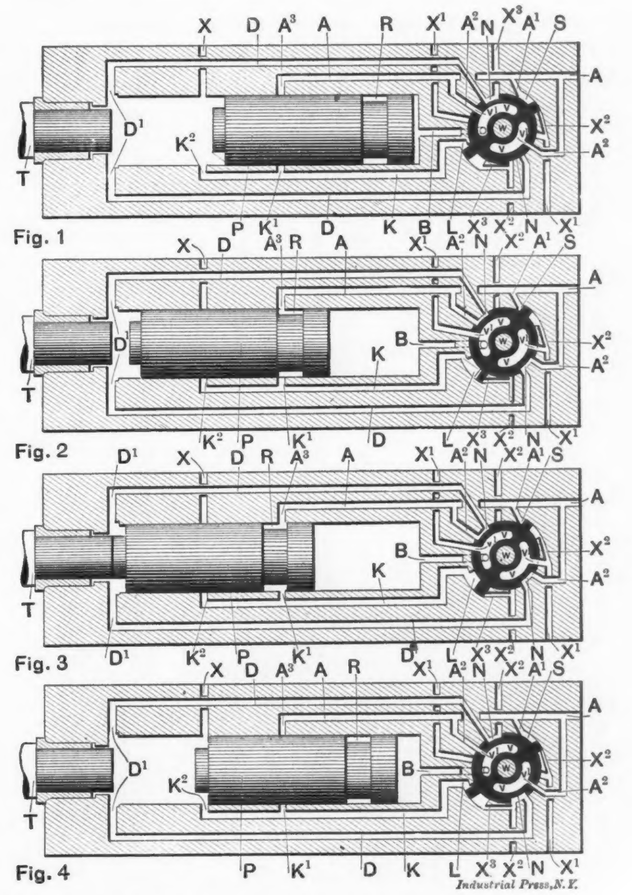
rigidly to the adjustable cone *H* while its opposite face is formed in the shape of a marginal resilient flange *I*. Between this flange and the engaging portions of the outer nut is contained a locking washer *J* which has flexible teeth adapted to co-act with the notched portions of the two nuts. The outer nut *F* is also resilient in an axial direction on account of the web portion between the outer contact portions and the inner threaded part not coming in contact with the inner nut. The notches forming the teeth on the periphery of the locking washer *J* are differently spaced from those on the two nuts. In adjusting the bearing the inner nut is screwed up until there is no play between the balls and the raceway, then the outer nut is forced up until one or more of the teeth on the locking washer can be bent into the notches of each nut, thereby forming a solid positive lock at any adjustment.

A ball separating ring, or cage, *K*, is generally used but may be omitted in bearings where the conditions do not require it. This cage consists of a ring which is made a running fit on the cones *L* and *H*.

Fig. 4 shows how this same type of bearing is arranged to form a double unit. In the same manner a number of units may be combined to form a bearing of any length desired. Accidents resulting from breaking of balls or cracking of the raceways are practically impossible with these bearings, as the sleeves are made a running fit on the shafts to which they are applied so that if a ball should break, and the bearing stick, the shaft sleeve would run on the shaft as in a plain bearing.

### THE HAESELER-INGERSOLL PNEUMATIC HAMMER.

An entirely new line of pneumatic hammers has just been brought out by the Haeseler-Ingersoll Pneumatic Tool Co., of which the Ingersoll-Sergeant Drill Co., New York, are the general selling agents. The leading new feature about these hammers is the employment of what is called an "axial" valve, a photograph of which is shown in Fig. 5. The principle of this valve is that it oscillates about an axis which is in line with the center of the piston and the motion of the valve is consequently transverse to the direction of the piston movement. In this way vibration or reaction of the piston




Sections showing Operation of the Axial Valve.

does not affect the motion of the valve and as the bearing is small, friction, and consequently wear, is considerably reduced.

Figs. 1 to 4 are diagrams showing the ports spread out in place so that the action of the valve may be traced, the valve itself being indicated by the heavy black lines. As will be seen this valve is always balanced owing to the ports being diametrically opposite, and is always subjected to equal pressure.

Referring to Fig. 1, it will be seen that full pressure enters *A* and passes down into the space *S*, and acts against the

short vane, holding the valve in the position as given in Fig. 1, full pressure air then enters through a tube and a port in the valve *V*1 and passes down to the back of the piston throwing the piston forward, when the slot *R* passes a port in cylinder *A*3, full pressure air is allowed to pass out through the port *K*1 and up through *K* into space *L* and acts on the opposite side of the long wing which immediately throws the valve to its second position in which the space back of the piston is open to the outside air through the valve at *V*1 and

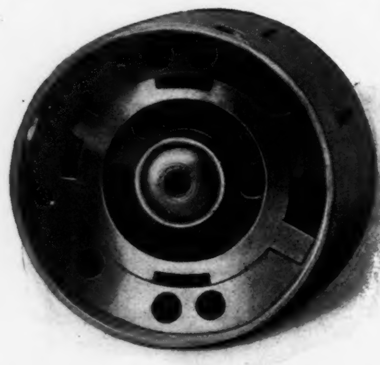


Fig 5. "Axial" Valve of Haeseler Pneumatic Hammer.

the port *X*1. At the same time suitable slots in the valve connect the full pressure air supply with the passage *D*1, which leads to the front of the piston, thus admitting full pressure air in front and throwing the piston back to its original position. This does not occur, however, until the piston has expended its full energy on the end of the chisel blank, as shown in Fig. 3. As the piston moves back it exposes ports *K*2 to the air through *X*, which allows the air in the front of the piston and also in the space *L* to exhaust, allowing the full pressure air which comes in through *A* to throw the valve to the original position as shown in Fig. 1. This cycle is repeated with a rapidity which depends on the air supply at *A*, which is governed by the throttle.

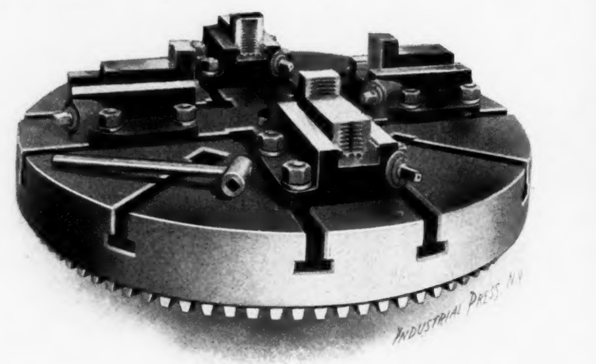
The valve, which is a small, light forging, works on a central bearing which forms a part of the valve box. This box has a cover, and both box and cover are provided with dowel pins, which insure their dropping into place when they are put in the hammer. In this way the hammer can be taken apart or put together by the ordinary operator. Owing to the valve and valve box being independent of the handle, it is not necessary to have a lot of extra handles about, as is the case where the valve is in the handle, and a couple of extra valve boxes will keep a good size plant in operation owing to this interchangeable feature.


Fig. 6. Haeseler Pneumatic Chipping Hammer.

The efficiency of a pneumatic hammer is seriously impaired if the joints between the faces of the cylinder, valve box and handle are not kept tight. To insure keeping these joints tight, by securely locking the parts together, a simple and strong construction is provided by a number of slots which are cut in the collar of the cylinder while a different number of notches are cut in the other end of the handle, the one number not being a multiple of the other. This arrangement permits a fine adjustment to be made when it is desired to take up the wear of the parts, as a notch in the handle will always be in line with one of the slots in the cylinder, without regard to any required position of the handle being necessary. When the handle is screwed up tight, the parts are locked together by a key being inserted in the registering slot and notch referred to, and is held in place by a spring band being snapped over it and around the collar of the cylinder.

### A SPIRAL GEARED CHUCK JAW.

The new chuck jaw, illustrated in the accompanying half-tone, has been adapted by the Bullard Machine Tool Co., Bridgeport, Conn., for use on their boring and turning mills and has been placed on the market for use with any chuck. For use on their own machines, the jaw is provided with four clamping bolts, suiting it to the parallel table slots; but it is also made with two bolts so that it may be attached to any faceplate having radial slots. Upon the under side of the sliding jaw is cut a rack which engages with the feed screw.

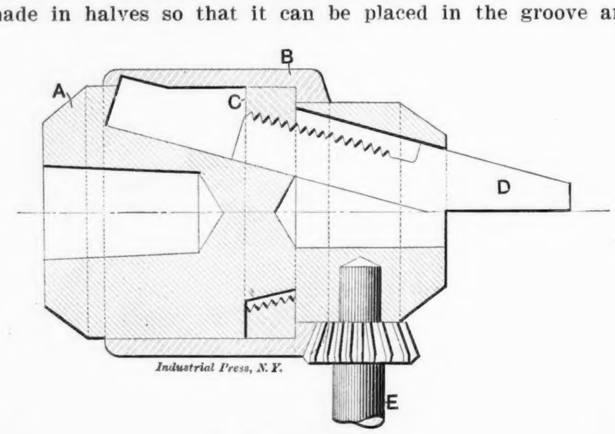



Boring Mill Chuck with Spiral Geared Jaw.

This screw is set at an angle with the axis of the slide and the rack is cut at a corresponding angle, so that a powerful clamping force is exerted in the direction of the slide. The screw can be operated from either end and, being set at an angle, the wrench is thrown away from the work so that the operator has an opportunity to tighten the screw from the most advantageous position. Using a rack instead of a nut on the sliding jaw, permits the jaw to be made lower and therefore allows it to clamp the work much nearer to the face of the table than would otherwise be possible.

### A NEW STYLE OF DRILL CHUCK.

The line cut herewith shows a section through a very novel drill chuck that has just been placed on the market by A. I. Jacobs, Hartford, Conn. Although resembling in general appearance, the ordinary drill chuck, the method by which it is operated is entirely new and has proved very efficient. In the main body of the chuck, *A*, there is turned a groove in which runs the threaded ring *C*. This ring is made in halves so that it can be placed in the groove and



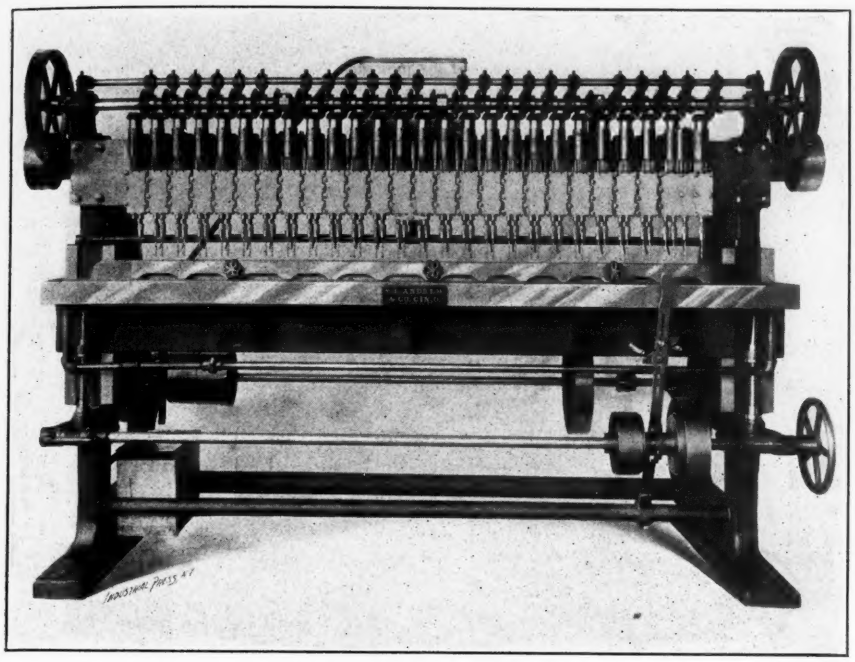

The Jacobs Drill Chuck.

after it is put in, the sleeve *B* is forced over it. This sleeve runs loosely over the body of the chuck but fits the ring *C* so tightly that it forms with it an integral part of the chuck. Turning the sleeve *B* causes the ring to draw the threaded blades *D*, of which there are three, in or out, thus clamping or releasing the drill. The outside of the sleeve is knurled for turning it by hand and the front edge is cut with teeth for tightening it by the use of the toothed key *E*.

This key is slipped into a hole in the nose of the chuck so that the teeth come into mesh with those on the front of the sleeve and enable a very powerful gripping force to be imparted to the shank of the drill. One of the advantages of this chuck over one in which the tightening is accomplished by means of a spanner or similar contrivance, is that while the spanner tends to turn the spindle, making necessary the use of one hand to prevent it, with this chuck there is no tendency for the spindle to turn.

## FIFTY-ONE SPINDLE MULTIPLE DRILL.

A few years ago it was a rare thing to see a drill press or drilling machine of any kind that was equipped with more than a dozen spindles, but at the present day the number of spindles that may be applied to a drill seems to be limited only by the demands of the work. The accompanying photograph illustrates a vertical drilling machine, fitted with 51 spindles, that was designed for drilling steel cutter bars for reaping and mowing machines. With this machine the entire 51 holes are drilled in practically the same time that was formerly spent in drilling a single hole and the bars are all exact duplicates. The spindles are arranged to drill part of the holes as close as 7/8-inch, center to center, while the balance are drilled with 2 1/8-inch center distances. The former dimension is a fixed quantity but the distance between the latter spindles can be adjusted to suit different spacings of the holes. The steel bars that are drilled average about 78 inches in length by 7/8 inches in width, and are firmly held in a suitable chuck, which is drawn together with three small hand wheels. This chuck is made adjustable and can be set to bring the drills directly over the center of the bar.



Fifty-one Spindle Multiple Drill.

The work is fed up to the drills with a strong friction feed and the table is returned with a 7 to 1 reverse feed. Automatic stops are fitted to the friction lever to regulate the travel of the table in both directions. An upper and lower tank is fitted to each machine with a geared pump between for pumping the drilling compound into the upper tank from which the drills are supplied. These machines are built in various sizes by M. L. Andrew & Co., Cincinnati, Ohio.

## A NEW WATER TOOL GRINDER.

Since the advent of the use of an emery wheel for tool grinding it has been the aim of the grinding machine builders to provide for keeping a regulated supply of water upon the wheel. The method adopted by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., in a new grinder which they have just placed on the market, is illustrated in the accompanying cuts, Figs. 1 and 2. Fig. 1 is a general view of what is rated as their No. 3 grinder while the diagram, Fig. 2, shows the way in which water is applied to the wheel. The column of the grinder is divided into two compartments, or chambers, *A* and *C*, the lower compartment *C* being made air-tight. These two chambers are connected by the pipe *G* which runs from the normal water level in the upper chamber down nearly to the bottom of the lower chamber *C*. At the side of the column, supported on a bracket, is the pneumatic pump *F* which is connected by a small pipe to the air-tight chamber in the column.

When the machine is first set up, water is poured into the upper trough *A* and as soon as this is filled to the top of the pipe *G*, the water runs down the pipe into the lower chamber. In order to allow the water to flow into this chamber the pet cock *E* is opened so that the air may escape when the water enters. As soon as water begins to flow from the cock the chamber is known to be filled; the cock is then closed and the machine is ready for operation. Whenever the water in the upper trough falls below the normal level it is only necessary to introduce a little air into the lower chamber, by a few strokes of the pump, and this forces the water up through the pipe *G* into the trough. As the storage chamber is large and the pipe *G* runs nearly to the bottom, one filling is capable of lasting for an indefinite time and the weight of the water in the base also adds to the stability of

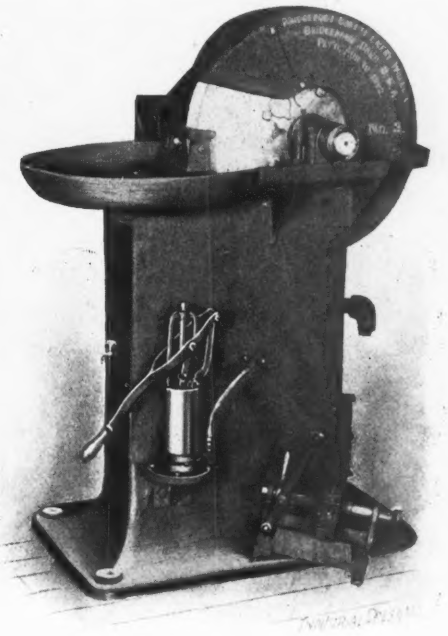


Fig. 1. New Water Tool Grinder.

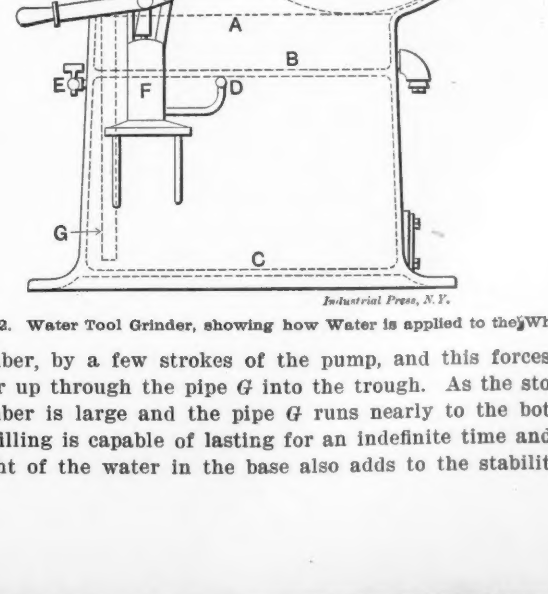
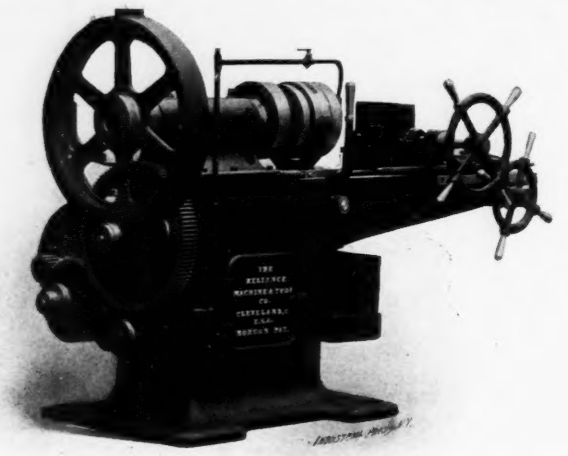



Fig. 2. Water Tool Grinder, showing how Water is applied to the Wheel.

the machine. No parts of the pump in any way come in contact with the water so there is practically no wear or damage from dirt or particles of grinding dust that get into the water.

### MOTOR-DRIVEN BOLT CUTTERS.

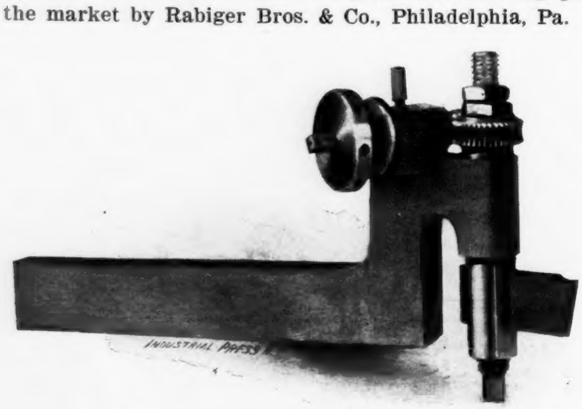
In line with the growing tendency toward electrically-driven machinery the Reliance Machine & Tool Co., Cleveland, Ohio, have just equipped their line of bolt cutters for motor-drives. The machine illustrated, which is the 2-inch cutter, is driven by a Crocker-Wheeler reversible, variable speed motor. The speed variation, obtained by field control, is as 1 to 3 and the motor is connected by means of spur gearing directly to the machine. The motor being fastened to the back side of the bolt cutter is readily accessible, free from grit and oil, and occupies very little floor space. The gears are carefully covered with casings which are not shown in the illustration.



Two-inch Bolt Cutter with Motor Drive.

### A FILLET TURNING TOOL.

The difficulty and expense usually involved in making a radius tool, whenever it is desired to turn a fillet in a shaft or other lathe work, is well known to every machinist. It is also known that as the tool is fed in toward the center of the work it soon begins to cut metal on all sides and this inevitably produces chatter, especially with the larger tools. To remove this difficulty the fillet turning tool shown in the photograph herewith has been designed and is being placed on the market by Rabiger Bros. & Co., Philadelphia, Pa.



Fillet Turning Tool.

The shank of this tool is held on the carriage in the regular manner while the cutting tool is clamped in the revolving toolpost which is rotated by the worm and worm-wheel. The worm may be operated by hand even when heavy cuts are being taken, but the operating knob is drilled for the application of a spanner or lever when the work is too severe for hand feed. To obtain any required radius it is only necessary to set the tool in or out from the center of the revolving toolpost the required amount. The tool may be instantly adjusted to any position by removing the small pin and turning the eccentric knob, shown back of the feed knob. This disconnects the worm from the worm wheel and leaves the toolpost free to be turned at will. Curves of any radius can be cut with this tool and, having once set the cutter properly, it is impossible to make a fillet of wrong radius or to cut other than an accurate curve.

### ROBERTSON POWER HACK SAW.

A new power saw that has just been placed on the market by the Robertson Mfg. Co., Buffalo, N. Y., is illustrated in the half-tone herewith. This saw is gear driven, operating the saw blade at a rate of one stroke per four revolutions of the driving pulley. A sliding bar with top guide and crank connections all in center line with the saw insures a true stroke. The swing carriage with large bearings allows the saw frame to travel naturally and mechanically in the cut and at the same time raise on the return stroke relieving the drag on the teeth. The sliding weight can be instantly adjusted for different hardnesses of metal. A stud back of the vise, stops the machine when the work is completed and a flat lever then holds the frame up automatically. An adjustable gage is provided for cutting bars, disks, pipes, etc., to exact length. This, the No. 3 size, has a capacity for cutting work up to 8 x 8 inches.

Robertson Power Hack Saw.

### THE "SIMPLEX" VARIABLE SPEED COUNTERSHAFT.

In modern shop practice, especially when using the new high-speed steels and motor drives, there is a growing demand for closer speed regulation than can be obtained by the use of cone pulleys or geared drives, as the variations in speed obtained in this way must vary by comparatively large steps. A countershaft is therefore required in which the variations in speed may be made by finer gradations, since it is often desirable to effect a variation of as little as 5 per cent. in order to obtain the maximum efficiency from the tools. The "Simplex" countershaft, here described, is arranged to effect these variations by the use of two drums formed of wooden slats which travel in and out of milled slots in the face of tapered disks. One of these drums is driven at a constant speed, from the line shaft, while the other is mounted upon the variable shaft from which the machine is driven. Both shafts are carried in a substantial frame which also supports the mechanism by means of which the disks are operated. This mechanism consists of a pair of levers working together so that they simultaneously draw one pair of flanges apart and force the other pair together. The movement is effected by means of a pinion meshing with racks on the lever arms and is operated by turning a shaft placed at any convenient position on the machine.

The drums are connected by two wide belts for transmitting power and a narrow belt which so wraps around them as to retain the slats that are not covered by the driving belts. Between the drums is placed an idler which insures a constant belt contact of 270 degrees. As will be seen, the power is transmitted by direct belt pull at the face of the drum so

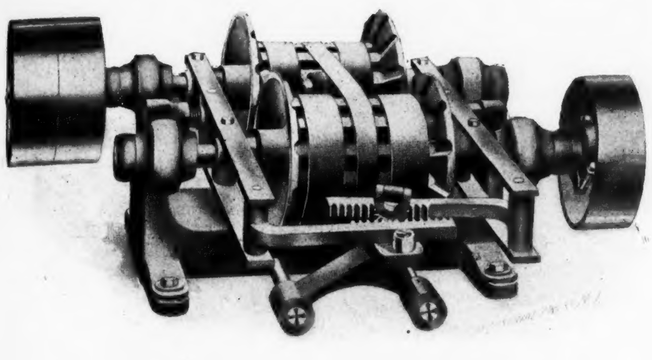


Fig. 1. "Simplex" Variable Speed Countershaft.

that there is no twisting movement whatever and the loss of power in transmission is consequently very small.

The action of the countershaft is clearly illustrated by the diagrams shown in Fig. 2, in which *C* represents the shaft running at a constant speed and *V* is the shaft from which the machine is driven and which runs at a speed that varies

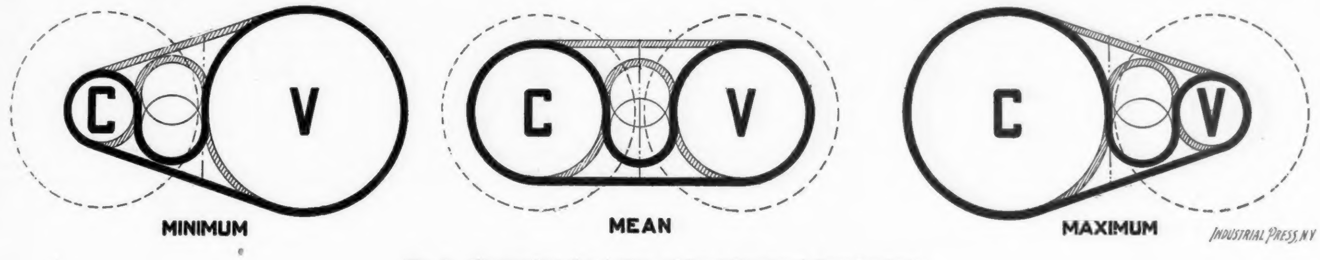



Fig. 2. Illustrating the Action of the "Simplex" Countershaft.

as the ratio of the diameters of the two drums is changed. The full black line represents the driving belt and the sectioned line is the retaining belt. In the first position shown the drum on the constant speed shaft is reduced to its smallest diameter and the variable speed shaft is consequently driven at its slowest speed. The last view shows the constant speed drum raised to its largest diameter, in which case the variable shaft is driven at its greatest speed. The total variation of speeds obtainable is 10 to 1

When the mechanic has discovered the most efficient speed at which his machine should be driven he desires a mechanical device to indicate this speed so that, in the future, when he has occasion to use the same speed he can immediately adjust the countershaft to obtain it. By such a device he can tell at a glance whether his machine is working at its full capacity. A device of this kind is a part of the equipment of this countershaft, and it is known as the speed controller. On the face of this controller are scored efficient cutting speeds at which the tool should be driven and all that the operator has to do is to turn the hand wheel until the indicator finger registers the number for the particular case in hand.

This controller is also equipped with a device which will automatically increase the speed of the tool. For instance, on boring mills where the cut is from the outside to the center, by a series of worms and star feed the controller is arranged to increase the speed of the tool as it approaches the center. This countershaft is built in sizes from one to five hundred horse power by the Speed Control Co., Philadelphia, Pa.

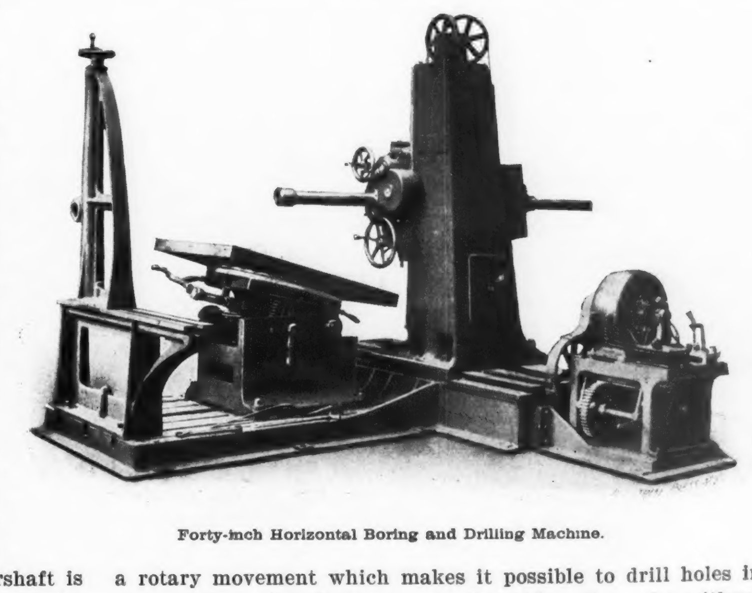
## A RAPID REDUCTION LATHE.

The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, have brought out a "rapid reduction" lathe designed especially for heavy turning with the new high-speed tool steels. The bed is of unusually rigid and heavy construction and of such form that the downward pressure of the cut will come directly under the tool. The carriage and tailstock are carried on independent ways, at the front and back of the bed respectively, so that it is possible for the carriage to pass entirely by the tailstock. The power feed is operated from the apron and may be automatically released at any point by means of adjustable stops. The feeds range from 1-32 to 1-3 inch per revolution of the spindle for either turning or screw cutting. Provision is made on the carriage for using two or more tools which are carried in independently adjustable tool blocks. The lathe is driven by a 6-inch belt running on a three-step cone pulley and all the gearing of the headstock is carefully guarded with iron casings.

## FORTY-INCH HORIZONTAL BORING AND DRILLING MACHINE.

A machine that is adaptable to a very wide field of shop use is the horizontal boring and drilling machine that is illustrated in the accompanying photograph. It consists of a bed plate on the high portion of which is fitted a column that is arranged to have longitudinal traverse. On this column is a saddle carrying a spindle which is provided with a geared feed motion and the end is arranged for a Morse taper. The saddle is fully counterbalanced and is raised and lowered by hand. The spindle is moved by hand, either slowly for feeding or rapidly by spoke wheel for quick adjustment, and in addition it has several power feeds.

To the other portion of the bed plate is fitted a universal table which is capable of handling work of several thousand pounds weight. This table has a sliding movement to and from the column, being operated by a rack and pinion. The top has a pivoted movement, from a horizontal to a vertical plane, and can be rigidly clamped at any angle. It also has



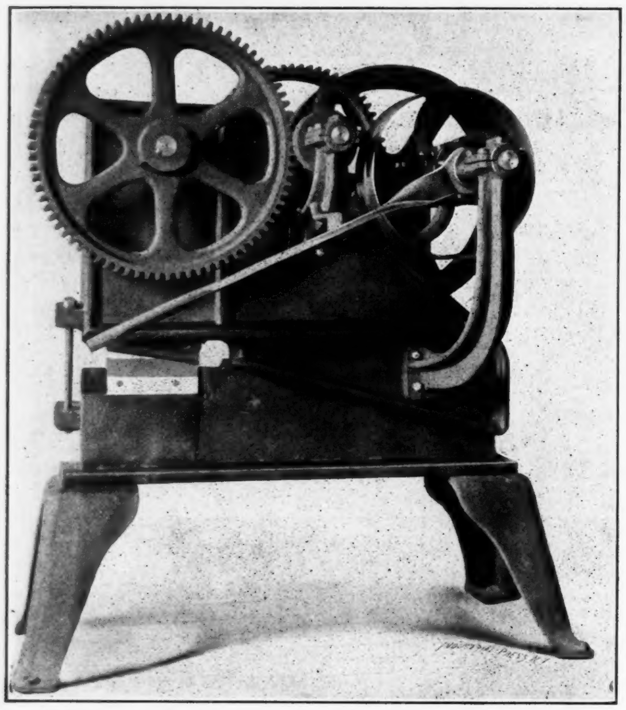
Forty-inch Horizontal Boring and Drilling Machine.

a rotary movement which makes it possible to drill holes in any part of a hemisphere or in five sides of a cube without rechucking the work. If large work is to be machined the table can be removed from the bed. When the machine is used for boring, an outside support for the bar is provided which can be used either with or without the universal table. Steel scales for accuracy of adjustment are furnished if desired.

When the machine is motor-driven, as in the illustration, a special arrangement of cone gearing is provided to give the different speeds to the spindle without the use of belts. The machine is manufactured by the Detrick & Harvey Machine Co., Baltimore, Md.

### BOILERMAKERS' SPLITTING SHEAR.

The machine shown below is a boilermakers' splitting shear of the type having an offset frame in line with the throat, which permits the two parts of a plate being cut, to pass freely on each side without distortion, save that one piece is bent downward at a slight angle as it leaves the shear blade to pass under the offset portion of the frame. To make the matter clearer the frame section in the plane of the throat is made like one step of a stairs, and one piece of the



Boilermakers' Splitting Shear.

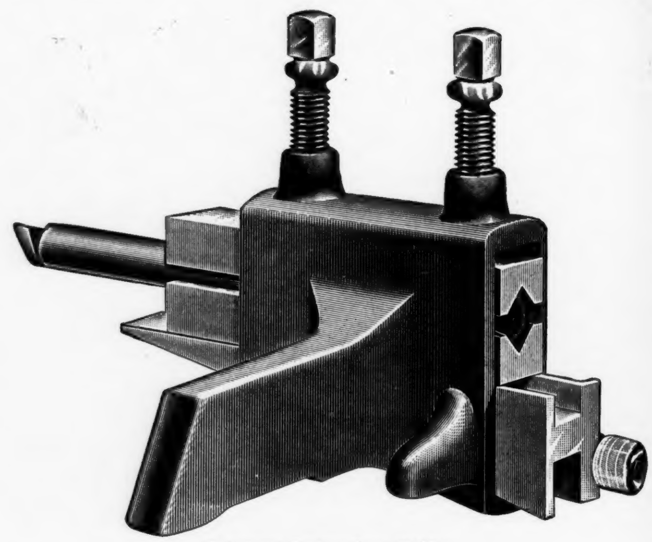
split plate passes along the upper side of the step (on the opposite side of the machine from that shown) and the other portion along under the step on the side shown. The ratio of gearing is 20 to 1, and a clutch is provided for starting. The machine is made in three sizes for ½, 9-16 and ⅝-inch plates respectively, and in each size the shear blade is 10 inches long. When shearing plates the tie-bolt shown in the cut is removed, but it should be in place when cutting bar stock. The shear is made and sold by the W. C. Young Mfg. Co., Worcester, Mass.

### A QUICK RETURN FOR THE MILLING MACHINE PLATEN.

The Carter & Hakes Machine Co., Winsted, Conn., have recently adopted an automatic quick return mechanism for the table of their Lincoln type of milling machines. The purpose of the mechanism is to automatically and quickly return the table as soon as the end of the cut is reached. The return movement is thrown into operation as soon as the feed worm is released from its connection with the wormwheel on the feedscrew and, since it is driven from the countershaft by an independent belt, the return is always at the same speed irrespective of the speed at which the forward feed may be operating. When the quick return belt is not in operation it runs upon a loose pulley. A lever, attached to the end of the carriage, shifts the belt from this pulley onto the driving pulley as soon as the end of the table travel is reached, and thereby throws the quick return into operation. When the table has completed its return a dog engages the lever and throws the belt back onto the loose pulley again. The mechanism may be applied to any machines of this type and it in no way interferes with the regular arrangement for moving the table by hand.

### A UNIVERSAL BORING TOOL HOLDER.

The "Tiffany" universal boring tool holder which is illustrated herewith, was designed for general use with tools of round, hexagon or square steel as well as for holding flat, straight shank, and gun drills. The tool, which is held between two V-blocks, is rigidly clamped by two setscrews in such a manner as to insure no chattering. In addition to the adjustments obtainable with the usual type of tool holder

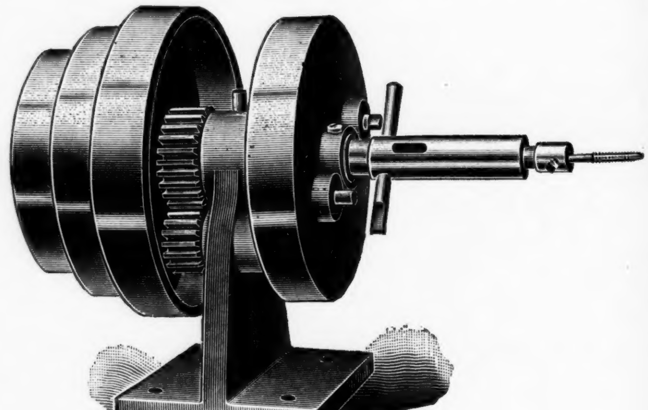


Universal Boring Tool Holder.

this has the advantage of a vertical adjustment, which will be found often of great convenience. The vertical movement is obtained by loosening the two clamping screws and moving the wedge in or out by means of a knurled thumb screw and taper wedge. This keeps the cutting tool constantly parallel with the work. These holders are made in three sizes and their sale is controlled by the Miami Valley Machine Tool Co., Dayton, Ohio.

### AUTOMATIC TAPPING MACHINE.

A new and very convenient tapping machine, capable of tapping holes up to ⅜-inch, is illustrated in the cut herewith. The mechanism is so arranged in the casing that the spindle will stop after the reverse on each tap, leaving it stationary while the machine is running at full speed. This enables



Automatic Tapping Machine.

the cone pulley to act both as tight and loose pulley, and backing and feeding belts are not required. The tap on reaching the bottom of the hole reverses at a speed two and one-half times as fast as the feed and there is no friction whatever occasioned by the reversal. This machine is the product of the Atlas Machine Tool & Die Works, Cincinnati, Ohio.

J. W. Bourn, who for the past year has been a foreman in the machine shop of the Gruson Iron Works, Eddystone, Pa., has tendered his resignation and has accepted the position of assistant superintendent of the George V. Cresson Co., Philadelphia.

## FRESH FROM THE PRESS.

The American Steel Worker, by E. R. Markham. Published by the Derry-Collard Co. New York. 343 8vo. pages. Illustrated. Price $2.50.

This is the first important work to be issued by the Derry-Collard Company, which was organized something more than one year ago. It is written by a man who has given many years to the subject of the treatment of steel and is considered an authority on this subject. The company is fortunate to have this volume with which to introduce itself to the public as publishers. Mr. Markham has been a frequent contributor to Machinery, and to other technical papers, of articles upon the treatment of steel. He has made a specialty of hardening, annealing, and tempering, giving particular attention to pieces that cannot be treated by the ordinary processes. Such information as he has acquired has been freely given to the public, and in the present volume his various writings have been gathered together and thoroughly revised and added to. The person who wishes to study the subject of steel and its treatment will here find a simple and clear treatise, dealing both with elementary principles and with the more difficult classes of work. The importance of the cutting tool in shop cost reduction is being demonstrated every day, and the information about hardening and tempering such tools, as well as the treatment for dies, milling cutters, and irregularly-shaped pieces which Mr. Markham gives, ought to prove of direct benefit financially to any concern. Our only regret is that he did not enter more fully into the question of the modern high-speed steels which are now absorbing so much attention. This subject is not taken up to any extent. In publishing the work the Derry-Collard Co. have made new cuts throughout, to the number of 160, and the paper, press work and general appearance of the book are good.

Directory to the Iron and Steel Works of the United States 15th Edition. Published by the American Iron and Steel Association, 261 South Fourth Street, Philadelphia. 450 pages. Price, cloth, $10.

This latest edition of the directory is revised down to the closing months of 1901 and contains full descriptions of the equipment of all blast furnaces. Bessemer, open hearth and crucible steel works, tin and terne plate works, forges and bloomaries in each state. These descriptions are accompanied by names of the officers, selling agents, and a full account of their products, together with such other information as one would look for in a publication of this character. There is a full list of the consolidations that have taken place during the past few years and an account of their capitalization and of the properties absorbed by them. There is also a description of all of their acquired properties, such as coal and iron mines, coke ovens, etc., as well as the steel works themselves. All of the iron and steel works not consolidated are also described, the arrangement being by states and districts. There is also a classification by states of the works, except blast furnaces, according to their products. A complete account is given of the iron and steel enterprises completed or undertaken in the Dominion of Canada down to December 31, 1901. The last few pages of the book are devoted to noting any changes of organization that took place while it was in the process of publication, so that the work is brought right up to the date of going to press.

Supplement to the Directory to the Iron and Steel Works of the United States. Published by the American Iron and Steel Association, Philadelphia. 196 pages. Price, cloth, $5.

This contains a classified list of the leading consumers of iron and steel in the United States, and has been issued to comply with the demand for accurate and detailed information concerning these consumers, such as locomotive builders, car builders, car-wheel makers, pipe makers, bridge builders, tin plate manufacturers, etc. The information incorporated in this supplement would have been included in the last edition of the Directory, but time did not permit, so this separate volume was prepared, which is, we are told, the most comprehensive ever compiled by the Association. The book will prove of great value in connection with the Directory, which it supplements, and with which it is intended to be used.

## NEW TRADE LITERATURE.

The Narragansett Machine Co., Providence, R. I. Illustrated catalogue of mallets, clamps, etc., for patternmakers.

The Betts Machine Co., Wilmington, Del. Catalogue of planing machines. These are shown in the following sizes: 36, 42, 48, 54, 60x48, 60, 72x60, 72, 84x72, 84, 96, 120x72, 120x96 inches, and are fully described.

The Grant Gear Works, 6 Portlandt Street, Boston, Mass. 1903 catalogue and price list of gears. These include ready-made iron and brass cut gears of many sizes and for various purposes; cast gears, machine chains and sprockets, etc.

The H. H. Franklin Mfg. Co., Syracuse, N. Y. Booklet treating of the Franklin motor-car. An air-cooled motor is used, which prevents all troubles due to overheating. This is illustrated and described in the booklet, as are also the Franklin engine and running gear.

The Holtzer-Cabot Electric Co., Brookline, Boston, Mass. Attractive brochure illustrating the application of the company's motors to various classes of machinery. This is handsomely gotten up, and shows the Holtzer-Cabot motor driving a planer, a molder, jig saw, cut-off saw, circular saw, band saw, printing press, etc.

The C. W. Hunt Co., West New Brighton, Staten Island, N. Y. Pamphlet No. 034 of industrial railways, which, though small, is very comprehensive. This lists the Hunt industrial railway tracks, switches, crossings, turntables and a large variety of industrial and special cars for all purposes.

The Wells Bros. Co., Greenfield, Mass. Illustrated 1903 catalogue and price list of screw cutting tools and machinery. This contains 115 pages, and lists very completely the many and various tools manufactured, among which are chucks, countershafts, reamers, dies and die holders, wrenches, taps, etc.

The New Process Raw Hide Co., Syracuse, N. Y. Attractive booklet entitled "Noiseless Gearing," calling attention to the raw hide gears and pinions manufactured by this company. These can be used on motor-driven pumps, hoists, air compressors, blowers, machine tools and cranes; wood working, metal working and many other machines; gas and gasoline engines; carbonating machines, and in fact everywhere that gears are necessary.

The Watson-Stillman Co., New York. Catalogue No. 65, April, 1903, of hydraulic machine tools for a great variety of purposes. Hydraulic jacks, hydraulic punches, benders, lever punches and shears, presses, hydraulic machines and pumps, accumulators, riveters, etc., are illustrated. This catalogue indicates that since the issuance of their catalogue No. 51, a number of new tools have been added to the large line already manufactured.

The Northern Electrical Mfg. Co., Madison, Wis. Bulletin No. 30 of direct-current generators. This is copiously and handsomely illustrated and shows the application of the Northern generators to Corliss engines of various types, standard high-speed engines, and to steam turbine engines. These generators are described in detail and the bulletin will prove of interest to those giving their attention to the subject of electric drive.

The Geo. Leyner Engineering Works Co., Denver, Colo. Catalogue, 1903, of the Water Leyner rock drill, Model 5A, which is described and illustrated in detail. This drill is furnished with a water attachment in the form of a small steel tank, 18 gallons capacity, having an inlet connection for air and an outlet connection for water. This is for cleaning out the holes being drilled. Several views of the drill in operation are shown.

The Root & Van Dervoort Engineering Co., East Moline, Ill. Illustrated catalogue, 1903, of the "R" & "V" gas and gasoline engines and distillate engines. Horizontal gas and gasoline engines, direct-connected lighting engine, portable gasoline engines, vertical engines for pumping and running light machinery are all described in detail, and cuts of these engines and of their various parts also appear. The "R" & "V" duplex power pump for pumping water into elevated tanks or reservoirs, etc., is also shown.

The Bullard Machine Tool Co., Bridgeport, Conn. Pamphlet, standard size, entitled "A Treatise on Boring and Turning Mills." This deals with the vertical boring and turning mills built, which range in sizes from 30 inches to 120 inches, with one and with two swivel turret heads. One-half of the pamphlet is devoted to full-page illustrations of the various operations performed on these mills, which give an excellent idea of the work done. This booklet is handsomely gotten up and both printer and manufacturer deserve credit for its splendid typographical appearance.

## MANUFACTURERS' NOTES.

Wm. Ganschow, manufacturer of gears, who was formerly located at 31-37 So. Canal Street, Chicago, has moved to 12-14 So. Clinton Street, that city.

K. A. Painter has resigned his position as foreman with the Westinghouse Machine Co. to accept that of master mechanic with the McKeesport Tin Plate Co., McKeesport, Pa.

John E. Lord, chief draftsman with Hooven, Owens & Rentschler Co., Hamilton, O., has resigned his position to accept one in the Engine Sales Department of the Allis-Chalmers Co. in their New York office.

Mr. Eugene Kibeler, formerly machine shop foreman with the Bullock Electric Mfg. Co., Cincinnati, O., recently resigned his position to accept one as assistant general foreman with the General Electric Co.

The Northern Metallic Packing Co., St. Paul, Minn., have appointed W. P. Crockett, who is vice-president of the St. Paul Railway Supply Mfg. Co., representative of their company to handle the Northern metallic packing and the Curran locomotive chime whistle, which they manufacture.

H. B. Underwood & Co., Philadelphia, Pa., have recently built an addition to their shop in Hamilton Street, doubling their capacity. All the old tools have been replaced by up-to-date ones, and they state that their shop is now better equipped than any other of its size. The company manufacture high-grade portable cylinder boring bars, portable rotary valve seat planing machines, special portable tools, etc.

H. Bickford & Co. Lakeport, N. H., recently organized under this name, are engaged in the manufacture of boring and turning mills. Mr. Bickford has been in the machine tool business thirty years, and fifteen years at Lakeport, where he has established the present prosperous business. Mr. William Nelson, of this firm, was for a number of years associated with the Boston office of the Nelson Fairbanks Co., and has a wide acquaintance among the trade.

The Turner Brass Works, 50 No. Franklin Street, Chicago, Ill., are distributing to the trade their new 56-page illustrated catalogue of gasoline torches and other gasoline appliances. These include several new styles of double jet torches and other appliances recently placed on the market and the old reliable torches and Straight-Turner Brazing Forges. The Turner double jet torches are fully described, and the company explain why these produce twice the heat of the ordinary gasoline torches.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., have appointed J. F. Ahern formerly with the Scully Steel & Iron Co., to assist A. G. Hollingshead their western sales manager. Also H. B. Griner, late assistant manager of the Chicago Pneumatic Tool Co., to a position in their main office. The company report large orders for chipping hammers, riveters and drills from the Craig Shipbuilding Co., Toledo; Willamette Iron & Steel Co., Portland, Oregon; Kewanee Boiler Works United Gas Improvement Co., J. D. Connell Iron Works, New Orleans; Chandler & Taylor Co., Allis-Chalmers Co., and others.

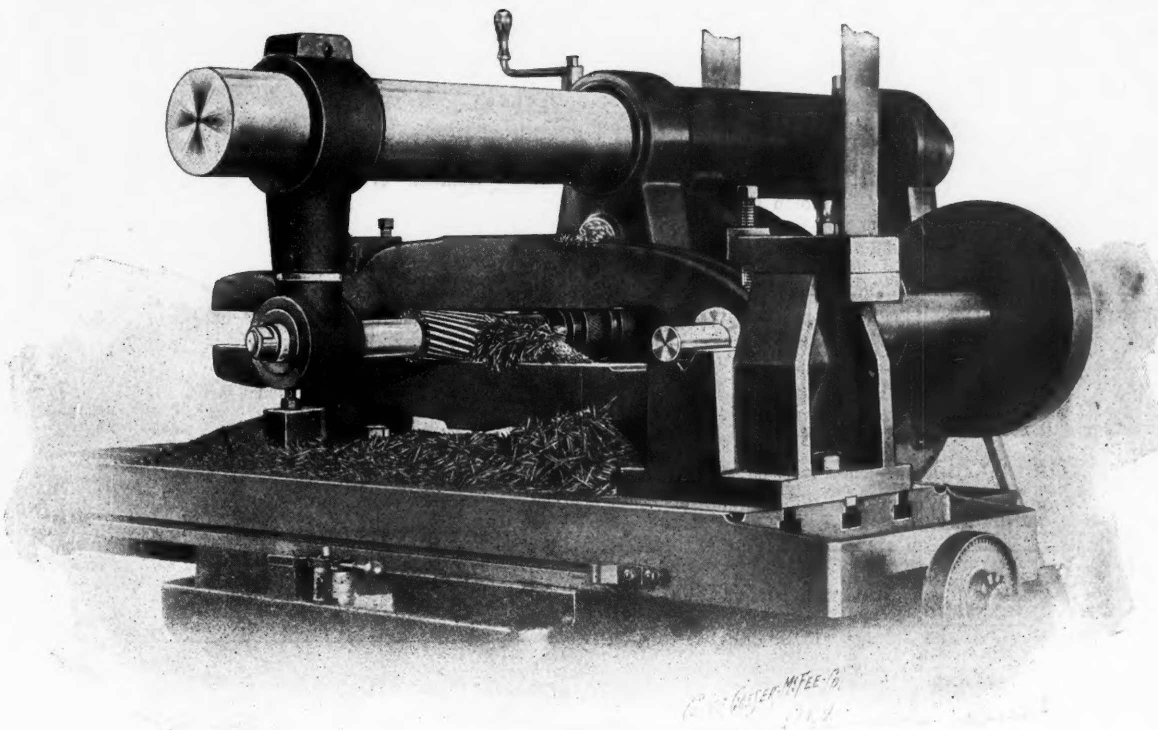
The Cincinnati Milling Machine Co., Cincinnati, O. 32-page pamphlet, showing illustrations and giving data on 28 milling operations taken from actual practice and indicating the work for which the Cincinnati geared feed millers are adapted. It is issued for free distribution among shop men with a view to giving instruction on the subject of milling. The data cover a wide range of work and are suggestive of the methods used and results that can be obtained. They also embody the recommendations of the Cincinnati Milling Machine Co., in respect to the use of their machines.

The Consolidated Press & Tool Co., 96-100 No. Clinton Street, Chicago, Ill., is the name of a corporation recently organized for the manufacture of presses, dies, sheet metal tools and special machinery, and for the designing and developing of special and automatic machinery and attachments for the economical working of sheet metal in all its branches. H. C. H. Walsh, the company's vice-president, has spent twenty years designing and building sheet metal tools, and T. J. Potter, secretary and business manager, is well known to the trade and will give his attention to the selling of the company's products. The firm's president is Chas. S. Burton.

## MISCELLANEOUS.



[Continued on page 38D).



# This Beats Planing 6 to 1.

We take the opportunity to show you this month how the Cincinnati Shaper Co. finish the rocker arms for their 24-inch shapers all over—12 surfaces in all—in two settings, and in a very short time, on a

# No. 4 Plain Geared Feed Cincinnati Miller.

The top and bottom of the piece and the two slots are finished with the cutter shown in illustration. It is 2¾ in. diameter, takes a cut 1-16 in. deep by 2¾ in. wide at top and bottom of slot at the same time, feeding 3 inches per minute. ***They mill the piece complete in 2¼ hours—used to take 14½ hours to plane it.*** The feed is changed eight times by our quick feed-changing device—no time lost. It would take half an hour to get these feed changes on any other No. 4 Plain Miller.

What do you think of the size of that cut? Would your millers take it? And how much show would a planer have? Watch for the final operation next month.

Write us for ***"Examples of Rapid Milling."***

**We are Milling Specialists.**

## The Cincinnati Milling Machine Company,

**Cincinnati, Ohio, U. S. A.**

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels, Stockholm. Adolphe Janssens, Paris. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Niles-Bement-Pond Co., 23 and 25 Victoria St., London, S. W.

CANADIAN AGENTS—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

**MISCELLANEOUS** (Continued from page 38B).

DRAFTSMEN desiring occasional extra business in line with drafting; state where regularly employed; confidential. Address EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

EXPERIENCED mechanical draughtsman wanted. Permanent employment assured to rapid and accurate draughtsman. Address "MILL WORK," care MACHINERY, 66 West Broadway, New York.

FOR SALE CHEAP.—An office telephone system with five stations, in good order. Address, "TELEPHONE," care of MACHINERY, 66 West Broadway, N. Y.

MACHINISTS' 50-PAGE BOOK.—"Pointers and Rules," 25 cents; try it; agents wanted. WM. POWLES, 485 North Street, St. Paul, Minn.

MACHINISTS WANTED.—Wages $2.50 per day of 9 hours, or more according to ability; time and a half for overtime, steady employment. DE LAVAL STEAM TURBINE CO., Trenton, N. J.

MONARCH STEEL WELDING COMPOUND is not a cheap welding compound, it is made for high grade steel, such as tool steel, cast steel and crucible steel, and welds them solid without loss of time. Send for free sample. W. M. TOY, Sidney, Ohio.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

PATENT YOUR ORIGINAL IDEAS.—They may be valuable some day. If in doubt as to patentability, write me, giving sketch and full description, and I will give you my opinion as to patentability free of charge. F. H. KING, Patent Lawyer and Solicitor, 1462 Monadnock Bldg., Chicago, Ill.

SALESMEN WANTED for United States and Canada to sell the best cold saw cutting-off machine on the market. A liberal arrangement made with dealers and salesmen who will push our line. Address, RESEK MACHINE TOOL CO., Cleveland, Ohio.

Special machinery, tools, dies and fixtures. F. S. KING & CO., 32 Elm Street, West Haven, Conn.

THE Wellman Sole Cutting Machine Co., of Medford, Mass., designs and builds light machinery. Correspondence solicited.

TEXTILE MACHINERY.—Engineers having 9 years' technical and practical experience offer their services for the construction and introduction of a larger Textile machine (Embroidery Machine) not yet constructed, in America. Address "D 4046," care Haasenstein & Vogler, A. G., Chemnitz, Saxony.

WANTED—DRAFTSMEN.—200 actual vacancies for technical men; 5,000 positions filled in ten years. ENGINEERING AGENCY, 109 Monadnock Block, Chicago, Ill.

WANTED.—All kinds experienced engineers, draftsmen, foremen and superintendents to register; positions open. CLEVELAND ENGINEERING AGENCY, Box 71, Station B, Cleveland, O.

WANTED.—Contract and jobbing work on medium and heavyweight machinery. Prompt delivery. U. S. RAPID-FIRE GUN & POWER CO., Derby, Conn.

WANTED.—A machinist in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH, Columbia, Pa.

WANTED.—Heavy boring mill and lathe work; also machinery to build on order. KROM MACHINE WORKS, 10 Essex St., Jersey City, N. J.

WANTED.—Nos. 1 and 3, Volume 1, of MACHINERY. Correspond with GEORGE C. WARNER, Box 33, Claremont, N. H.

WANTED.—By a practical machinist and marine engineer, position as foreman, master mechanic or superintendent of construction. Contracted and built Rolling Mills, Distillery, Cooperage and Glucose Machinery; also built, tested and set up Marine Engines in steamers. Best of reference. Chicago reference, Robert Tirant Engine & Tool Builder. Address "J. C. F," care MACHINERY, 66 West Broadway, New York.

WANTED.—Lathe, planer, milling machine and vise hands, in works located within easy distance of New York and Philadelphia; manufacturing high-speed engines, and employing 200 to 300 men; steady employment; good wages and conditions to desirable men; state age and experience. "ENGINES," care of MACHINERY, 66 W. Broadway, N. Y.

WANTED.—First-class machinists, and especially fitters, experienced on Vertical Boring and Turning Mills. Good wages and steady employment. No labor troubles. COLBURN MACHINE TOOL CO., Franklin, Pa.

WANTED.—First-class Tool Room Foreman. Must have good executive ability and a knowledge of designing and building tools, gauges and fixtures. Address TOOL ROOM, care MACHINERY, 66 W. Broadway, N. Y.

WANTED.—Immediately, 50 lathe, planer, milling machine and vise hands; steady employment and good wages; we build engine lathes and other machine tools. Apply to or address THE W. P. DAVIS MACHINE CO., Rochester, N. Y.

WANTED.—A competent and energetic Foreman for Brass Manufacturer making Brass Fittings. One who is a good manager of men and systematic in the handling of work, also practical in designing tools. A growing opportunity for the right man. Address with reference, "BRASS MANUFACTURER," care MACHINERY, 66 West Broadway, N. Y.

WANTED.—A Factory Superintendent for progressive manufacturer of Brass and Iron Fittings. A man versed in general machinery and tool practice and thoroughly systematic in management of work and output. Must be qualified in the handling of men and perfectly reliable for taking charge of factory. Give references and address "MANUFACTURER," care MACHINERY, 66 W. Broadway, New York.

WE are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and machinists. We always have vacancies. Address THE WESTINGHOUSE MACHINE CO., East Pittsburg, Pa.

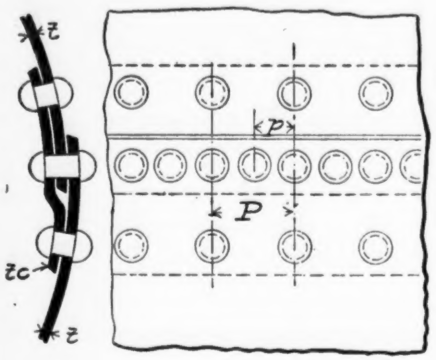
WE are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and core-makers. We always have vacancies. Address ALLIS-CHALMERS CO., Lock Box No. 1065, Chicago, Ill.

WE have a fine line of special machinery to make and are equipping a plant for its manufacture. We want a competent man to take management and invest from five to fifteen thousand dollars. Address "MANAGER," care MACHINERY, 66 West Broadway, N. Y.

PUNCH PUNCH

CREASE HERE.

## Single-Riveted Lap-Joint with Inside Cover-Plate.




(1) Resistance to tearing between outer row of rivets $= (P - d)\, t\, T$

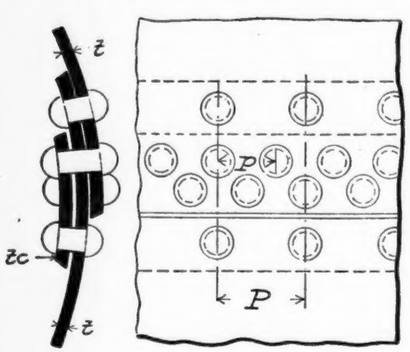
(2) Resistance to tearing between inner row of rivets, and shearing outer row of rivets $(P - 2d)\, t\, T + \frac{\pi d^2}{4} S$

(3) Resistance to shearing three rivets $\frac{3\pi d^2 S}{4}$

(4) Resistance to crushing in front of three rivets $= 3\, t\, d\, C$

(5) Resistance to tearing at inner row of rivets, and crushing in front of one rivet in outer row $= (p - 2d)\, T + t\, d\, C$

## Double-Riveted Lap-Joint with Inside Cover-Plate




(1) Resistance to tearing at outer row of rivets $= (P - d)\, t\, T$

(2) Resistance to shearing four rivets $= \frac{4\pi d^2}{4} S$

(3) Resistance to tearing at inner row and shearing outer row of rivets $(P - 1\frac{1}{2} d)\, t\, T + \frac{\pi d^2}{4} S$

(4) Resistance to crushing in front of four rivets $= 4\, t\, d\, C$

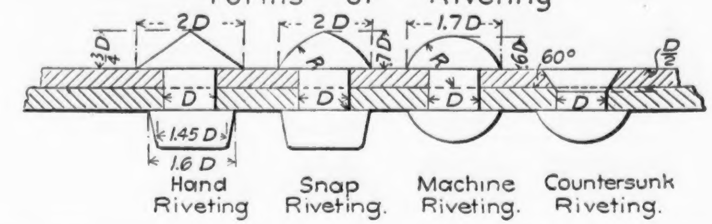
(5) Resistance to tearing at inner row of rivets, and crushing in front of one rivet $= (P - 1\frac{1}{2} d)\, t\, T + t\, d\, C$



PUNCH PUNCH

CREASE HERE.

## Forms of Riveting




## Tensile Strength of Plate per 1 inch of Width.

| Thickness. | Tensile strength per square inch | | | | |
|---|---|---|---|---|---|
| | 50000 | 55000 | 60000 | 65000 | 70000 |
| 1/16 | 3125 | 3437 | 3750 | 4062 | 4375 |
| 1/8 | 6250 | 6875 | 7500 | 8125 | 8750 |
| 3/16 | 9375 | 10312 | 11250 | 12187 | 13125 |
| 1/4 | 12500 | 13750 | 15000 | 16250 | 17500 |
| 5/16 | 15625 | 17187 | 18750 | 20312 | 21875 |
| 3/8 | 18750 | 20625 | 22500 | 24375 | 26250 |
| 7/16 | 21875 | 24062 | 26250 | 28437 | 30625 |
| 1/2 | 25000 | 27500 | 30000 | 32500 | 35000 |
| 9/16 | 28125 | 30937 | 33750 | 36562 | 39375 |
| 5/8 | 31250 | 34375 | 37500 | 40625 | 43750 |
| 11/16 | 34375 | 37812 | 41250 | 44687 | 48125 |
| 3/4 | 37500 | 41250 | 45000 | 48750 | 52500 |
| 13/16 | 40625 | 44687 | 48750 | 52812 | 56875 |
| 7/8 | 43750 | 48125 | 52500 | 56875 | 61250 |
| 15/16 | 46875 | 51562 | 56250 | 60937 | 65625 |
| 1 | 50000 | 55000 | 60000 | 65000 | 70000 |

## Shearing Strength of Rivets. (Single Shear)

| Diam. of Rivet | Area of Cross-Section. | Shearing strength per square inch. | | | | |
|---|---|---|---|---|---|---|
| | | 30000 | 35000 | 40000 | 45000 | 50000 |
| 3/8 | .1104 | 3312 | 3864 | 4416 | 4968 | 5520 |
| 1/2 | .1963 | 5889 | 6870 | 7852 | 8833 | 9815 |
| 5/8 | .3068 | 9204 | 10738 | 12272 | 13806 | 15340 |
| 3/4 | .4418 | 13254 | 15463 | 17672 | 19881 | 22090 |
| 7/8 | .6013 | 18039 | 21045 | 24052 | 27058 | 30065 |
| 1 | .7854 | 23562 | 27489 | 31416 | 35343 | 39270 |

## Crushing Strength of Rivets.

The crushing strength of rivets and plates, in joints that fail by crushing, is found by experiment to be high and irregular. In some cases it has amounted to 150,000 lbs per square inch; in a few tests it has been less than 85,000 lbs. per square inch. A value of 95,000 lbs. may be used with safety for general calculations



PUNCH PUNCH

PUNCH O PUNCH O

CREASE HERE.

## Failure of Riveted Joints.

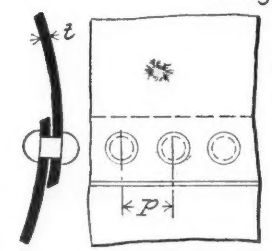
*A riveted joint may fail by shearing the rivets, tearing the plate between the rivets, crushing the rivets or plate, or by a combination of two or more of the above causes.*

*To determine the efficiency of a riveted joint, calculate the breaking strength by the different ways in which it may fail. That method of failure giving the least result will show the actual strength of the joint. If this equals $S_R$, and $S$= tensile strength of the solid plate, then efficiency = $\frac{S_R}{S}$*

### Nomenclature.

| | |
|---|---|
| $d$ = diameter of rivets. | $P$ = pitch of outer row of rivets. |
| $t$ = thickness of plate. | $S$ = shearing strength of rivets. |
| $t_c$ = thickness of cover plates. | $T$ = tensile strength of plate. |
| $p$ = pitch of inner row of rivets. | $C$ = crushing strength of rivets. |

### Single-Riveted Lap-Joint.

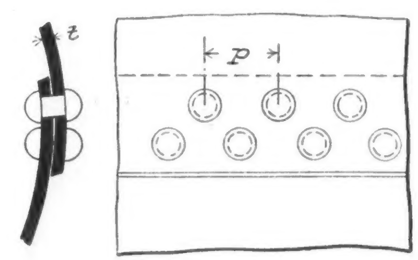



(1) Resistance to shearing one rivet $= \frac{\pi d^2}{4} S$

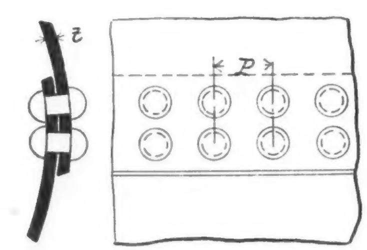
(2) " " tearing plate between rivets $= (p-d)\, t\, T$

(3) " " crushing of rivet or plate $= d\, t\, C$

### Double-Riveted Lap-Joint.




Staggered Riveting




Chain Riveting.

(1) Resistance to shearing two rivets $= \frac{2\pi d^2}{4} S$

(2) " " tearing between two rivets $= (p-d)\, t\, T$

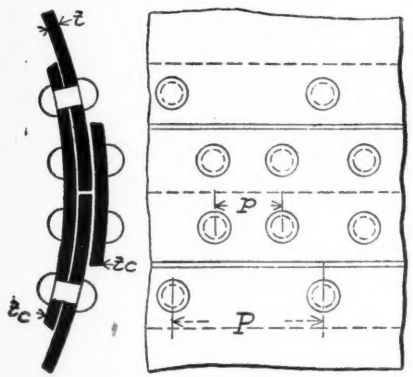
(3) " " crushing in front of two rivets $= 2 d\, t\, C$



PUNCH O PUNCH O

CREASE HERE.

## Double-Riveted Butt-Joint.




(1) Resistance to tearing at outer row of rivets $= (P-d)\, t\, T$

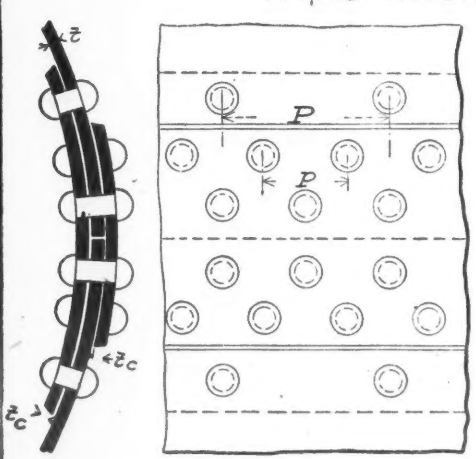
(2) Resistance to shearing two rivets in double shear and one in single shear $= \frac{5\pi d^2}{4} S$

(3) Resistance to tearing at inner row of rivets and shearing one of the outer row of rivets $= (P-2d)\, t\, T + \frac{\pi d^2}{4} S$

(4) Resistance to crushing in front of three rivets $= 3\, t\, d\, C$

(5) Crushing in front of two rivets and shearing one rivet $= 2\, t\, d\, C + \frac{\pi d^2}{4} S$

## Triple-Riveted Butt-Joint.




(1) Resistance to tearing at outer row of rivets $= (P-d)\, t\, F$

(2) Resistance to shearing four rivets in double shear and one in single shear $= \frac{9\pi d^2}{4} S$

(3) Resistance to tearing at middle row of rivets and shearing one rivet $= (P-2d)\, t\, F + \frac{\pi d^2}{4} S$

(4) Resistance to crushing in front of four rivets and shearing one rivet $= 4\, d\, t\, C + \frac{\pi d^2}{4} S$

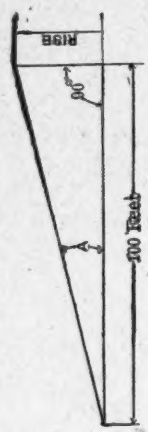
(5) Resistance to crushing in front of five rivets $4\, d\, t\, C + d\, t_c\, C$

CREASE HERE.

PUNCH

# TABLE OF FORCES ON INCLINED PLANES.

**Tensions and Pressures are in Pounds. Friction on Plane is not considered.**




| Per Cent. of Grade. Rise, Feet per 100 Feet. | Angle A. | Sine. | Cosine. | Tension in Cable per Ton of 2000 lbs. | Perpendicular Pressure on Plane per ton of 2000 lbs. |
|---|---|---|---|---|---|
| 1 | 0° 35′ | .0101 | .9999 | 20.2 | 1999.8 |
| 2 | 1° 9′ | .0200 | .9997 | 40.0 | 1999.4 |
| 3 | 1° 44′ | .0302 | .9995 | 60.4 | 1999.0 |
| 4 | 2° 18′ | .0401 | .9991 | 80.2 | 1998.2 |
| 5 | 2° 52′ | .0500 | .9987 | 100.0 | 1997.4 |
| 6 | 3° 27′ | .0601 | .9981 | 120.2 | 1996.2 |
| 7 | 4° 1′ | .0700 | .9975 | 140.0 | 1995.0 |
| 8 | 4° 35′ | .0799 | .9968 | 159.8 | 1993.6 |
| 9 | 5° 9′ | .0897 | .9959 | 179.4 | 1991.8 |
| 10 | 5° 43′ | .0996 | .9950 | 199.2 | 1990.0 |
| 11 | 6° 17′ | .1094 | .9939 | 218.8 | 1987.8 |
| 12 | 6° 51′ | .1192 | .9928 | 238.4 | 1985.6 |
| 13 | 7° 25′ | .1290 | .9916 | 258.0 | 1983.2 |
| 14 | 7° 59′ | .1388 | .9903 | 277.6 | 1980.6 |
| 15 | 8° 32′ | .1483 | .9889 | 296.6 | 1977.8 |
| 16 | 9° 6′ | .1581 | .9874 | 316.2 | 1974.8 |
| 17 | 9° 39′ | .1676 | .9858 | 335.2 | 1971.6 |
| 18 | 10° 13′ | .1773 | .9841 | 354.6 | 1968.2 |
| 19 | 10° 46′ | .1868 | .9823 | 373.6 | 1964.6 |
| 20 | 11° 19′ | .1962 | .9805 | 392.4 | 1961.0 |
| 21 | 11° 52′ | .2056 | .9786 | 411.2 | 1957.2 |
| 22 | 12° 25′ | .2150 | .9766 | 430.0 | 1953.2 |
| 23 | 12° 58′ | .2243 | .9745 | 448.6 | 1949.0 |
| 24 | 13° 30′ | .2334 | .9723 | 466.8 | 1944.6 |
| 25 | 14° 3′ | .2427 | .9700 | 485.4 | 1940.0 |
| 26 | 14° 35′ | .2517 | .9677 | 503.4 | 1935.4 |
| 27 | 15° 7′ | .2607 | .9653 | 521.4 | 1930.6 |
| 28 | 15° 39′ | .2697 | .9629 | 539.4 | 1925.8 |
| 29 | 16° 11′ | .2787 | .9603 | 557.4 | 1920.6 |
| 30 | 16° 42′ | .2873 | .9578 | 574.6 | 1915.6 |
| 31 | 17° 14′ | .2962 | .9551 | 592.4 | 1910.2 |
| 32 | 17° 45′ | .3048 | .9523 | 609.6 | 1904.6 |
| 33 | 18° 16′ | .3134 | .9496 | 626.8 | 1899.2 |
| 34 | 18° 47′ | .3219 | .9467 | 643.8 | 1893.4 |

Computed by Charles Kuderer, Allegheny, Pa.



CREASE HERE.

PUNCH

PUNCH

PUNCH

## FORMULAS FOR COIL SPRINGS. (From "Machine Design," by Prof. C. H. Benjamin.)

$L$ = length of axis of spring.
$l$ = developed length of wire $= \sqrt{\pi^2 D^2 n^2 + L^2}$
$D$ = mean diameter of spring = outside diameter − diameter of wire $= D^1 - d$.
$d$ = diameter of wire (length of side of square wire).
$n$ = number of coils.
$S$ = safe torsional or shearing strengh of wire. 2,500 for spring brass. (See table below for steel.)
$G$ = modulus of torsional elasticity. 6,000,000 for spring brass, 12,000,000 to 18,000,000 for steel.
$P$ = safe working load.
$X$ = Safe deflection.

For Round Wire.

$$P = \frac{S d^3}{2.55 D}$$

$$X = \frac{l D S}{G d}$$

For Square Wire.

$$P = \frac{S d^3}{2.12 D}$$

$$X = \frac{l D S}{G d \sqrt{2}}$$

## COMPRESSION TESTS ON COIL SPRINGS.

### SUMMARY OF TESTS MADE BY PROF. C. H. BENJAMIN, AT THE CASE SCHOOL OF APPLIED SCIENCE.

The object of the tests was to find the coefficient of torsional elasticity and the safe stress for springs made of different sizes of bars and having different ratios of diameter of spring to diameter of bar.

The value for $G$, the coefficient of torsional elasticity, is given in most hand-books as 12,000,000. In these tests the values ranged higher than this, the highest value being 18,900,000 and the lowest 12,500,000. This variation is due both to variation in temper and to slight differences in the chemical constituents of the steel. The average of all the tests is found to be 14,700,000, which may be written 14,500,000 for convenience. The size of bar has much to do with the safe value of $S$, the torsional stress in pounds per square inch, since it is not possible to work a large bar so that it will be as homogeneous as a small bar. Springs of small diameter may be safely subjected to a higher stress than those of large diameter, but the proportions should not be carried to an extreme, and a spring to have good service should have a mean diameter not less than three times the diameter of the bar.

For a good grade of steel the following values of $S$ have been found safe under ordinary conditions of service, the value of $G$ being taken as 14,500,000. The ratio of the mean diameter of spring to the diameter of bar is expressed by $R$ in the following:

For bars below 3/8 inch diameter:

$R = 3$ $S = 112,000$
$R = 8$ $S = 85,000$

For bars 7-16 to 3/4 inch in diameter:

$R = 3$ $S = 110,000$
$R = 8$ $S = 80,000$

For bars from 13-16 to 1 1/4 inches in diameter:

$R = 3$ $S = 105,000$
$R = 8$ $S = 75,000$

For bars over 1 1/4 inches in diameter a stress of more than 100,000 should not be used. Where a spring is subjected to sudden shocks a smaller value of $S$ is necessary.

The springs referred to in this paper are all compression springs with open coils. Experience has shown that in close coil or extension springs the value of $G$ is the same, but that the safe value of $S$ is only about two-thirds that for a compression spring of the same dimensions.

These data sheets are intended to be cut into four sections, 6 x 9 inches in size, as indicated by the straight lines. They may then be bound into note book form for convenient reference by means of staples inserted in holes punched at the points indicated.

PUNCH O PUNCH O

CREASE HERE.

## STRENGTH OF GEAR TEETH. (By Wilfred Lewis.)

$W$ = load transmitted in pounds.
$s$ = safe working stress of material.
$p$ = circular pitch in inches.
$f$ = face in inches.
$y$ = factor depending on the form of the tooth.
$v$ = velocity of tooth in feet per minute.
$d$ = diameter of gear in inches.

$$W = s\,p\,f\,y. \quad \text{H. P.} = \frac{W\,v}{33{,}000} = \frac{s\,p\,f\,y \times d \times r\,p\,m}{126{,}050} = .000007933\, d\,s\,p\,f\,y \times r\,p\,m$$

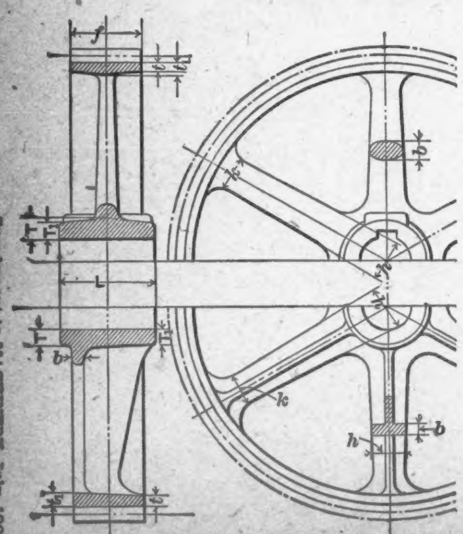
SAFE WORKING STRESSES, s, FOR DIFFERENT SPEEDS.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Speed of Teeth......... | 100 or less | 200 | 300 | 600 | 900 | 1,200 | 1,800 | 2,400 |
| Cast Iron............... | 8,000 | 6,000 | 4,800 | 4,000 | 3,000 | 2,400 | 2,000 | 1,700 |
| Steel..................... | 20,000 | 15,000 | 12,000 | 10,000 | 7,500 | 6,000 | 5,000 | 4,300 |

FACTOR FOR STRENGTH, y.

| No. of Teeth. | Involute 20° Obliquity. | 15° Involute and Cycloidal. | Radial Flanks. | No. of Teeth. | Involute 20° Obliquity. | 15° Involute and Cycloidal. | Radial Flanks. |
|---|---|---|---|---|---|---|---|
| 12 | .078 | .067 | .052 | 27 | .111 | .100 | .064 |
| 13 | .083 | .070 | .053 | 30 | .114 | .102 | .065 |
| 14 | .088 | .072 | .054 | 34 | .118 | .104 | .066 |
| 15 | .092 | .075 | .055 | 38 | .122 | .107 | .067 |
| 16 | .094 | .077 | .056 | 43 | .126 | .110 | .068 |
| 17 | .096 | .080 | .057 | 50 | .130 | .112 | .069 |
| 18 | .098 | .083 | .058 | 60 | .134 | .114 | .070 |
| 19 | .100 | .087 | .059 | 75 | .138 | .116 | .071 |
| 20 | .102 | .090 | .060 | 100 | .142 | .118 | .072 |
| 21 | .104 | .092 | .061 | 150 | .146 | .120 | .073 |
| 23 | .106 | .094 | .062 | 300 | .150 | .122 | .074 |
| 25 | .108 | .097 | .063 | Rack | .154 | .124 | .075 |

## PROPORTIONS OF GEARS. (By C. F. Blake.)



$p$ = circular pitch.
$R$ = pitch radius of gear in inches.
$n$ = number of arms.
$N$ = number of teeth.
$W$ = load at the pitch line = $s\,p\,f\,y$ (from above table).

Bending moment in each arm $M = \frac{WR}{n} = \frac{s p f y R}{n}$

For Elliptical Sections.

$$h = \sqrt[3]{2.7 \frac{f y p N}{n}}$$

$b = .6\,p$

For T-sections.

$$h = \sqrt[3]{1.6 \frac{f y p N}{n}}$$

$b = .6\,p$

Taper of $h$ = 7-16 inch per foot.
Taper of $b$ = 5-16 inch per foot.
$t = 0.47\,p$
$t = 0.56\,p$

$$T = \sqrt[3]{\frac{f p R}{8}}$$



PUNCH O PUNCH O

CREASE HERE.

## TABLE OF FORCES ON INCLINED PLANES (Continued).

| Per Cent. of Grade. Rise, Feet per 100 Feet. | Angle A. | Sine. | Cosine. | Tension in Cable per Ton of 2000 lbs. | Perpendicular Pressure on Plane per ton of 2000 lbs. |
|---|---|---|---|---|---|
| 35 | 19° 18′ | .3305 | .9438 | 661.0 | 1887.6 |
| 36 | 19° 48′ | .3387 | .9408 | 677.4 | 1881.6 |
| 37 | 20° 19′ | .3472 | .9377 | 694.4 | 1875.4 |
| 38 | 20° 49′ | .3553 | .9347 | 710.6 | 1869.4 |
| 39 | 21° 19′ | .3635 | .9315 | 727.0 | 1863.0 |
| 40 | 21° 49′ | .3716 | .9283 | 743.2 | 1856.6 |
| 41 | 22° 18′ | .3794 | .9252 | 758.8 | 1850.4 |
| 42 | 22° 47′ | .3872 | .9219 | 774.4 | 1843.8 |
| 43 | 23° 17′ | .3952 | .9185 | 790.4 | 1837.0 |
| 44 | 23° 45′ | .4027 | .9153 | 805.4 | 1830.6 |
| 45 | 24° 14′ | .4104 | .9118 | 820.8 | 1823.6 |
| 46 | 24° 43′ | .4181 | .9083 | 836.2 | 1816.6 |
| 47 | 25° 11′ | .4255 | .9049 | 851.0 | 1809.8 |
| 48 | 25° 39′ | .4328 | .9014 | 865.6 | 1802.8 |
| 49 | 26° 7′ | .4402 | .8978 | 880.4 | 1795.6 |
| 50 | 26° 34′ | .4472 | .8944 | 894.4 | 1788.8 |
| 51 | 27° 2′ | .4545 | .8907 | 909.0 | 1781.4 |
| 52 | 27° 29′ | .4614 | .8871 | 922.8 | 1774.2 |
| 53 | 27° 56′ | .4684 | .8834 | 936.8 | 1766.8 |
| 54 | 28° 23′ | .4753 | .8797 | 950.6 | 1759.4 |
| 55 | 28° 49′ | .4820 | .8761 | 964.0 | 1752.2 |
| 56 | 29° 15′ | .4886 | .8724 | 977.2 | 1744.8 |
| 57 | 29° 41′ | .4952 | .8687 | 990.4 | 1737.4 |
| 58 | 30° 7′ | .5017 | .8650 | 1003.4 | 1730.0 |
| 59 | 30° 33′ | .5082 | .8611 | 1016.4 | 1722.2 |
| 60 | 30° 58′ | .5145 | .8574 | 1029.0 | 1714.8 |
| 61 | 31° 23′ | .5207 | .8537 | 1041.4 | 1707.4 |
| 62 | 31° 48′ | .5268 | .8498 | 1053.8 | 1699.6 |
| 63 | 32° 13′ | .5331 | .8460 | 1066.2 | 1692.0 |
| 64 | 32° 38′ | .5392 | .8421 | 1078.4 | 1684.2 |
| 65 | 33° 2′ | .5451 | .8383 | 1090.2 | 1676.6 |
| 66 | 33° 26′ | .5509 | .8345 | 1101.8 | 1669.0 |
| 67 | 33° 50′ | .5567 | .8306 | 1013.4 | 1661.2 |
| 68 | 34° 13′ | .5623 | .8269 | 1124.6 | 1653.8 |
| 69 | 34° 37′ | .5680 | .8229 | 1136.0 | 1645.8 |
| 70 | 35° 0′ | .5735 | .8191 | 1147.0 | 1638.2 |
| 71 | 35° 23′ | .5790 | .8152 | 1158.0 | 1630.4 |
| 72 | 35° 46′ | .5844 | .8114 | 1168.8 | 1622.8 |
| 73 | 36° 8′ | .5896 | .8076 | 1179.2 | 1615.2 |
| 74 | 36° 31′ | .5950 | .8036 | 1190.0 | 1607.2 |
| 75 | 36° 53′ | .6002 | .7998 | 1200.4 | 1599.6 |

Computed by Charles Kuderer, Allegheny, Pa.